TM 11-6625-335-12

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR'S AND ORGANIZATIONAL
MAINTENANCE MANUAL

INDICATOR, STANDING WAVE RATIO
AN/UPM-108

HEADQUARTERS, DEPARTMENT OF THE ARMY

21 JUNE 1960

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful not to contact high-voltage connections or 115-volt input connections when testing or servicing the standing wave indicator.

DON'T TAKE CHANCES!

TECHNICAL MANUAL
No. 11-6625-335-12

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *21 June 1960*

INDICATOR, STANDING WAVE RATIO AN/UPM-108

			Paragraph	Page
CHAPTER	1.	INTRODUCTION		
Section	I.	General		
		Scope	1	3
		Forms and records	2	3
	II.	Description and data		
		Purpose and use	3	3
		Technical characteristics	4	4
		Table of components	5	4
		Common names	6	4
		Description	7	4
		Additional equipment required	8	5
CHAPTER	2.	INSTALLATION		
		Unpacking	9	7
		Checking unpacked equipment	10	7
		Installation	11	7
		Strapping power transformer for 230-volt ac operation	12	9
		Strapping power transformer for 115-volt ac operation	13	11
		Connections	14	11
		Initial adjustments	15	11
CHAPTER	3.	OPERATING INSTRUCTIONS		
Section	I.	Controls and indicators		
		General	16	13
		Standing wave indicator operating controls	17	13
	II.	Operation under usual conditions		
		Types of operation	18	14
		Detector probe penetration	19	14
		Preliminary starting procedure	20	14
		Starting procedure	21	15
		Measuring low standing wave ratio (below 10)	22	15
		Reading standing wave ratio in decibels	23	16
		Measuring high standing wave ratio (above 10) (double minimum method)	24	16
		Impedance measurement techniques	25	17
		Measuring rf load impedance	26	18
		Impedance measurement and the Smith chart	27	19
		Monitoring bias current of barretter detectors	28	23
		Recording meter indications	29	23
		Stopping procedure	30	23

			Paragraph	Page
CHAPTER	4.	OPERATOR'S MAINTENANCE		
		Scope of operator's maintenance	31	25
		Preventive maintenance	32	25
		Visual inspection	33	25
		Operational checklist	34	25
		Repairs and adjustment	35	28
CHAPTER	5.	ORGANIZATIONAL MAINTENANCE		
Section	I.	Maintenance		
		Scope of unit repairman's maintenance	36	29
		Tools, materials, and test equipment required	37	29
		Preventive maintenance	38	29
	II.	Troubleshooting		
		Visual inspection	39	31
		Equipment performance checklist	40	31
		Tube-testing techniques	41	33
		Replacement of 1,000-cps filter Z1	42	33
CHAPTER	6.	SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE		
Section	I.	Shipment and limited storage		
		Disassembly of equipment	43	34
		Repackaging for shipment or limited storage	44	34
Section	II.	Demolition of materiel to prevent enemy use		
		Authority for demolition	45	34
		Methods of destruction	46	34
APPENDIX	I.	REFERENCES		36
	II.	MAINTENANCE ALLOCATION CHART		37–39
	III.	FIRST ECHELON FUNCTIONAL PARTS LIST		42, 43

Figure 1. Indicator, Standing Wave Ratio AN/UPM–108, less running spares.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

This manual describes Indicator, Standing Wave Ratio AN/UPM-108 and covers its installation, operation, and operator's and organizational maintenance. It includes operation under usual conditions, and replacement of parts available to first and second echelon.

2. Forms and Records

a. Unsatisfactory Equipment Reports.

(1) Fill out and forward DA Form 468, Unsatisfactory Equipment Report, to the Commanding Officer, U. S. Army Signal Equipment Support Agency, Fort Monmouth, N. J., as prescribed in AR 700-38.

(2) Fill out and forward AF TO Form 29, Unsatisfactory Report, to the Commander, Air Materiel Command, Wright-Patterson Air Force Base, Ohio, as prescribed in AF TO 00-35D-54.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700-58 (Army), Navy Shipping Guide, Article 1850-4 (Navy), and AFR 71-4 (Air Force).

c. Preventive Maintenance Forms. Prepare DA Form 11-266 (fig. 18, 19 and 20) (Maintenance Checklist for Signal Equipment (Test Equipment)), in accordance with instructions on the form.

d. Parts List Form. Forward DA Form 2028 (Recommended Changes to DA Technical Manual Parts Lists or Supply Manuals 7, 8, and 9), directly to the Commanding Officer, U. S. Army Signal Equipment Support Agency, Fort Monmouth, N. J., for comments on parts listings in Appendixes II and III.

e. Comments on Manual. Forward all other comments on this publication directly to the Commanding Officer, U. S. Army Signal Publications Agency, Fort Monmouth, N. J.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Indicator, Standing Wave Ratio AN/UPM-108 is a portable test set used for making accurate standing wave ratio (voltage) (SWR) measurements for radar and microwave transmission systems when used with a suitable crystal detector mount and slotted line (coaxial or waveguide). It may also be used as a null detector in bridge circuits that require a sensitive 1,000-cycle indicator.

Note. The major components of Indicator, Standing Wave Ratio AN/UPM-108 are Indicator, Standing Wave Ratio IM-157/U and Cable Assembly, Power, Electrical CX-4864/U (2 ft 2 in.). The equipment is not contained in a common transit case; therefore, AN/UPM-108 does not appear on a nomenclature plate.

b. The slotted line and crystal detector mount used with the IM-157/U is determined by the frequency range of the radar or microwave equipment being tested. Various combinations of slotted lines and detectors that can be used are shown in figure 2. A 200-ohm barretter (bolometer) can be used in place of the crystal detector but it is not ordinarily used. This manual emphasizes operation with a crystal detector. The slotted lines and crystal detectors are not supplied.

c. The IM-157/U is tuned to a frequency of 1,000 cycles per second (cps) through the use of a factory installed, 1,000-cps plug-in filter. The frequency response may be changed to any frequency between 315 and 2,020 cps by replacing the 1,000 cps filter with another filter of the desired frequency which is not supplied. The filter frequency used cannot be a multiple of the powerline frequency.

Note. The filter frequency is stenciled on the filter. Throughout this manual, reference will be made only to the use of the 1,000-cps filter.

d. The meter scales on the IM–157/U are calibrated to indicate the following:

(1) Voltage standing wave ratio from 1 to 4 and 3 to 10 SWR.
(2) Expanded voltage standing wave ratio from 1 to 1.3 EXPANDED SWR.
(3) Noise level from 0 to 10 decibels (DB).
(4) Expanded noise level from 0 to 2 db (EXPANDED DB).

e. Cable Assembly, Power, Electrical CX–4864/U (2 ft 2 in.) is used to connect an external indicator (0–10 milliammeter) to the MONITOR jack for monitoring the barretter bias current. It is also used to connect an external milliammeter or recorder to the RECORDER jack for monitoring the current in the output meter circuit.

4. Technical Characteristics

Frequency range	1,000 cps ±2%.
Sensitivity	0.1 μv for full-scale meter deflection.
Noise level	Less than 0.03 mv.
Calibration	Square law. Meter indicates directly in db or voltage standing wave ratio.
Range	70 db (in 10-db steps).
Accuracy	±0.1 db per range. Maximum cumulative error ±0.2 db (range to range).
Input impedance:	
BOLO 200Ω	Bias current provided for 8.4 ma barretter (bolometer) type detector, or 4.3 ma for low-current barretter type detector used for power measurements.
XTAL 200Ω	Used with crystal detector.
XTAL 200KΩ ..	High impedance for special crystal detector used as null detector.
Line-voltage input ..	115 or 230 volts ac, 60 cycles.
Power consumption	55 watts.
Weight	13 pounds.

5. Table of Components

a. Components (fig. 1).

Quantity	Item	Height (in.)	Depth (in.)	Width (in.)	Unit weight (lb)
1	Indicator, Standing Wave Ratio IM–157/U	11¾	12½	7⅜	13
1	Cable Assembly, Power, Electrical CX–4864/U (2 ft, 2 in.)				0.5
2	TM 11–6625–335–12				
1 set	Running spares (*b* below)				

b. Running Spares (fig. 21).

Quantity	Item
5	Fuse Fl, 1 ampere (slow-blow type)
1	Incandescent lamp, 6–8 volts
1	Electron tube, OB2
1	Electron tube, 6AU5GT
1	Electron tube, 6AX5GT
1	Electron tube, 6DJ8/ECC88
1	Electron tube, 6CB6
1	Electron tube, 12AX7

6. Common Names

Nomenclature	Common name
Indicator, Standing Wave Ratio IM–157/U	Standing wave indicator
Cable Assembly, Power, Electrical CX–4864/U (2 ft, 2 in.)	Monitor cable

7. Description

(fig. 1)

a. The standing wave indicator is contained in an aluminum housing that has a leather carrying handle on top and a support bail on the bottom. The support bail is used to tilt up the control panel for better viewing during operation. The support bail folds up against the bottom of the housing when not in use. The panel-chassis assembly slides into the housing from the front and is retained in the housing by two screws inserted from the rear of the housing. All operating controls are located on the front panel. The alternating current (ac) line fuse is on the rear panel.

b. The monitor cable is a two-conductor cable assembly with a male telephone plug on one end and two lug-type terminals on the other end.

8. Additional Equipment Required

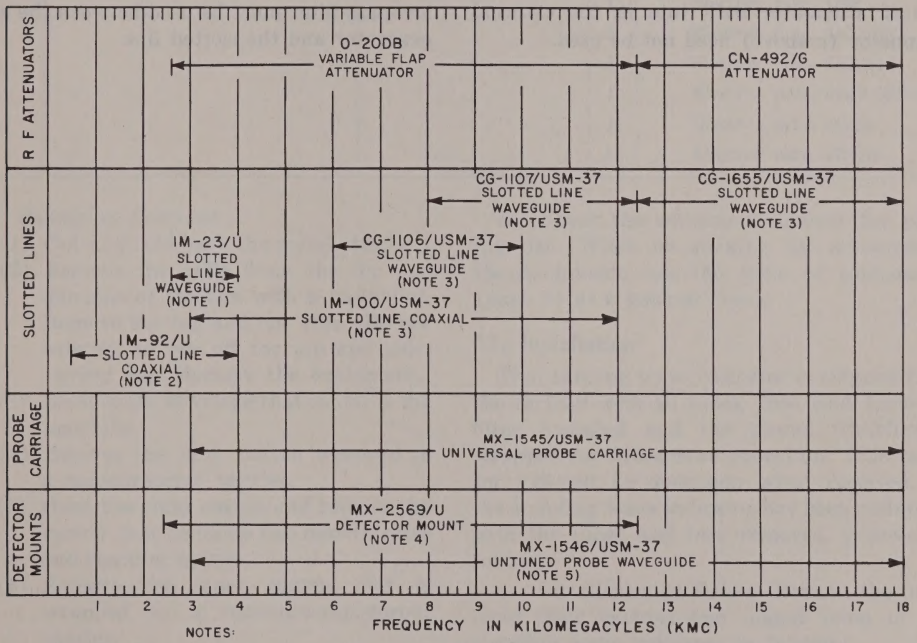
The following equipment is required for making swr measurements, but is not supplied as part of the AN/UPM-108.

a. Slotted Line Assembly. A coaxial slotted line or waveguide slotted line assembly is required for measurements. The specific slotted line used depends on the frequency of the radar or microwave equipment to be tested. Some slotted lines require a separate probe carriage; others do not as indicated in figure 2.

b. Detector Mount. A detector is required to rectify modulated radiofrequency (rf) and feed the audiofrequency (af) modulation to the standing wave indicator. The detector can be a 200-ohm barretter-type or a crystal detector. Figure 2 shows various combinations of slotted lines and detector mounts that can be used for frequency ranges from 0.5 to 40 kilomegacycles (kmc).

c. Rf Attenuator. An rf attenuator is required to isolate the load from the signal source and adjust power level in waveguides. The attenuator used depends on frequency and is matched with a slotted line as indicated in figure 2.

d. Test Cable Assemblies. A test cable assembly is required to connect the detector output to the INPUT connector on the standing



NOTES:

1. SELF-CONTAINED PROBE CARRIAGE; REQUIRES MX-1546/USM-37 PROBE, WAVEGUIDE.
2. SELF-CONTAINED PROBE CARRIAGE EQUIPPED WITH A TUNED DETECTOR MOUNT.
3. REQUIRES MX-1545/USM-37 PROBE CARRIAGE AND A SEPARATE DETECTOR MOUNT.
4. REQUIRES A SEPARATE BROADBAND PROBE.
5. SELF-CONTAINED DETECTOR MOUNT AND CRYSTAL (IN26 OR IN76).

TM6625-335-12-17

Figure 2. Equipment combinations used with standing wave indicator.

wave indicator. The cable assembly may be fabricated from a length of single-conductor type RG-58/U shielded cable with Connector Plug UG-88/U attached to each end. The length of the cable assembly should be as short as possible to reduce line losses.

e. Signal Generator. A signal generator which covers the desired frequency range and capable of modulating the frequency at 1,000 cps ±10 cycles is required. Square wave modulation is preferred because it reduces the effects of harmonics and frequency modulation in klystron-type generators to a minimum. A pulse-modulated (pm) signal generator may be used, but the duty cycle should not be less than 40 percent. If the signal generator has an accurate rf attenuator built into it, the external attenuator (*c* above) need not be used.

f. Milliammeters.

(1) A milliammeter with a full-scale deflection of 10 milliamperes (ma) and 20 ohms internal resistance is required for monitoring the bias current (through the MONITOR jack) when a barretter (bolometer) type detector is used.

(2) When the meter indications are to be recorded, a recording milliammeter with a 1-ma full-scale deflection and an internal resistance of 1,500 ohms is required.

g. Low-Pass Filters. Harmonics in the output of a signal generator may cause serious errors in slotted line measurements. Unless it is known that the output of the signal generator in use is free from harmonic content, a low-pass filter must be used between the signal generator and the slotted line.

CHAPTER 2
INSTALLATION

9. Unpacking

(fig. 3)

a. Packaging Data. When packed for shipment, the components of the AN/UPM-108 are placed in cartons and packed in a wooden box. A typical shipping box and its contents are shown in figure 3. The dimensions and contents of the shipping box are as follows:

Box no.	Size (in.)			Volume (cu ft)	Unit weight (lb)	Contents	
						Qty	Item
1	15	16½	11⅜	1.65	26	1	Standing wave indicator
						1	Monitor cable
						2	Technical manuals
						5	Fuse F1, 1 ampere, slow blow
						1	Incandescent lamp, 6–8 volts
						1	Electron tube, OB2
						1	Electron tube, 6AU5GT
						1	Electron tube, 6AX5GT
						1	Electron tube, 6DJ8/ECC88
						1	Electron tube, 6CB6
						1	Electron tube, 12AX7

b. Removing Contents.

(1) Cut and fold back the metal straps.

(2) Remove the nails from the top and one side of the box with a nailpuller. Remove the top and one side. Do not attempt to pry off the top and side; prying may damage the equipment.

(3) Remove the envelope that contains the manuals.

(4) Remove the outer carton wrapped in a moistureproof barrier.

(5) Open the outer carton and remove the carton that contains the remote cable and running spares.

(6) Remove the inner carton that is wrapped in a moisture-vaporproof barrier.

(7) Open the moisture-vaporproof barrier and open the inner carton.

(8) Remove the standing wave indicator from the inner carton.

10. Checking Unpacked Equipment

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, refer to paragraph 2.

b. Check the equipment against the packing list. When no packing list accompanies the equipment, use the table of components (para 5) as a general check.

11. Installation

The standing wave indicator is shipped from the factory with all tubes, fuse, and 1,000-cps filter installed and the power transformer strapped for 115-volt ac operation. It is ready for 115-volt ac operation when received. If the standing wave indicator has been reshipped with the tubes and fuse removed, proceed as follows:

a. Installation of Tubes. Remove the tubes from their cartons and install them in the standing wave indicator as follows:

(1) Remove the panel-chassis assembly from the housing by removing the Phillips-head screws on the rear panel (fig. 4).

(2) Pull the panel-chassis assembly forward out of the housing. Be careful not to scrape the power cord insulation.

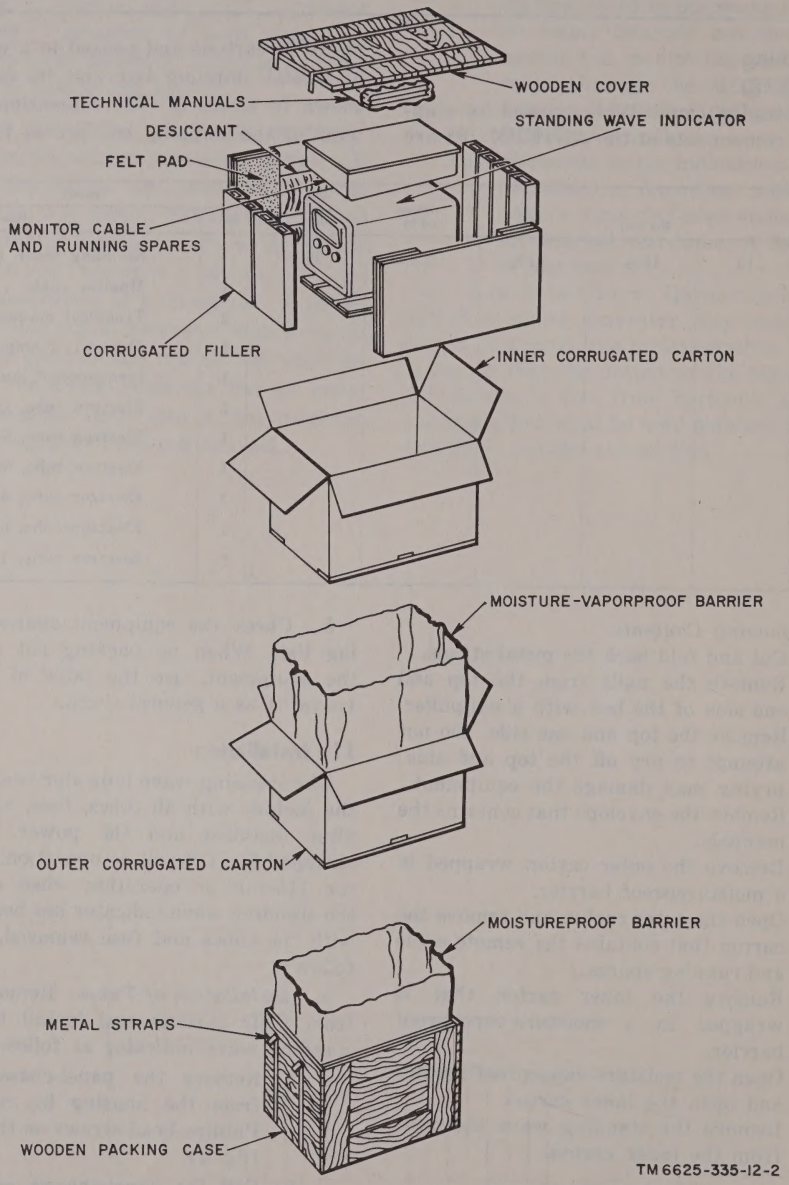


Figure 3. Typical packaging.

(3) Insert the tubes in the proper sockets (fig. 5).

(4) Replace the panel-chassis assembly in the housing and tighten the Phillips-head screws in the rear panel of the housing (fig. 4).

b. Fuse. Be sure the proper fuse is inserted in the fuse holder in the rear panel (fig. 4). If the power transformer is strapped for 115 volts ac operation (para 13), insert a 1-ampere, 250v slow-blow fuse. If the power transformer is strapped for 230 volts ac operation (para 12), insert a 0.5-ampere, (not supplied) slow-blow fuse.

12. Strapping Power Transformer for 230-Volt Ac Operation

If the standing wave indicator is to be operated from a 230-volt ac power source, refer to figure 6 and strap the power transformer terminal board as follows:

a. Remove the bare wire connections between terminals 1 and 2 and terminals 4 and 5 on the terminal board.

b. Connect a piece of No. 18 AWG solid insulated wire between terminals 2 and 4 on the terminal board.

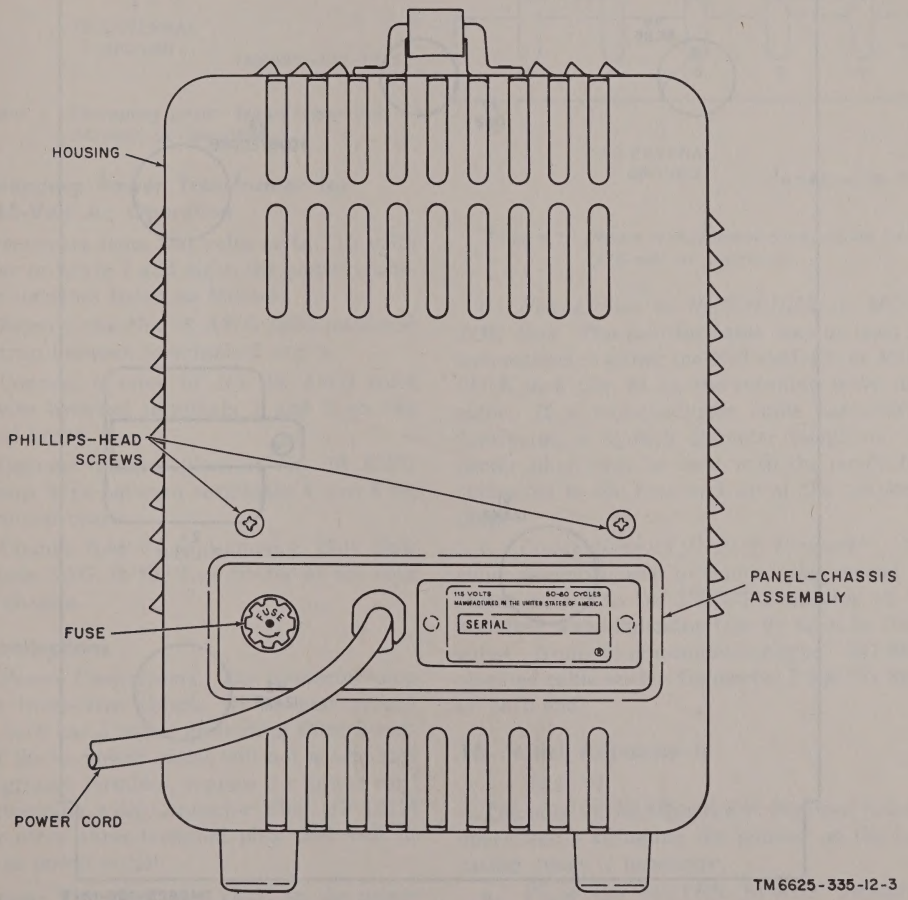


Figure 4. Rear panel, standing wave indicator.

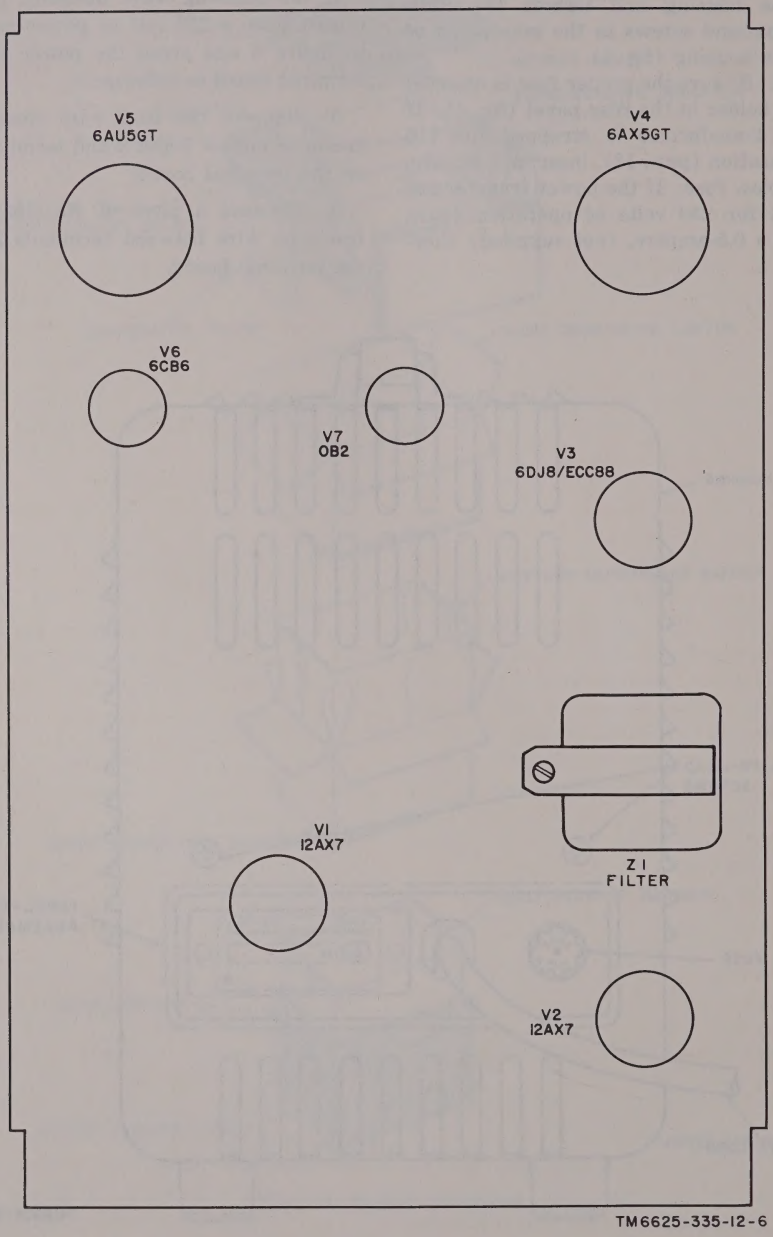


Figure 5. Tube location diagram.

c. Change fuse F1 to 0.5-ampere, slow blow, type 3AG, in the fuse holder at the rear of the chassis (fig. 4).

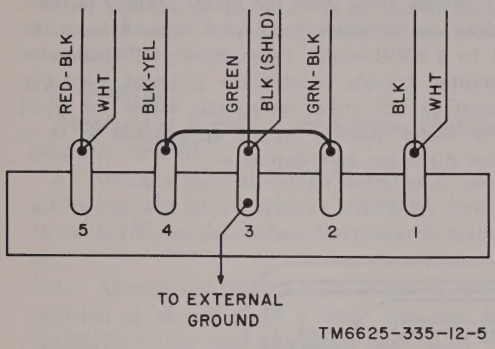


Figure 6. Strapping power transformer for 230-volt ac operation.

13. Strapping Power Transformer for 115-Volt Ac Operation

To reconvert from 230 volts ac to 115 volts ac, refer to figure 7 and strap the power transformer terminal board as follows:

a. Remove the No. 18 AWG solid insulated wire strap between terminals 2 and 4.

b. Connect a piece of No. 18 AWG solid bare wire between terminals 1 and 2 on the terminal board.

c. Connect another piece of No. 18 AWG solid bare wire between terminals 4 and 5 on the terminal board.

d. Change fuse F1 to 1-ampere, 250v slow blow, type 3AG, in the fuse holder at the rear of the chassis.

14. Connections

a. Power Connections. The connector plug on the three-wire (black, white, and green) power cord has a round grounding third terminal. If the ac power outlet will not accept this round ground terminal, replace the power cord connector plug with Connector Plug UP-121M or any other three-terminal plug that will fit in the ac power outlet.

Caution: **The black wire (hot) on the power cord must be connected to the narrow, ungrounded blade. The white wire must be connected to the white blade, which is the neutral (grounded) conductor. The green wire is a *safety* ground, and should be connected to a good external ground.**

Warning: **Never use the white wire (neutral) as a *safety* ground.**

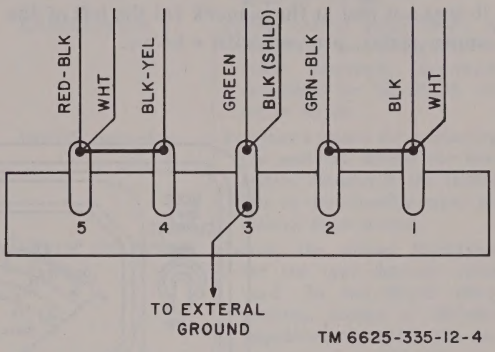


Figure 7. Power transformer connections for 115-volt ac operation.

b. Connections to RECORDER or MONITOR Jack. The monitor cable may be used for connections to either the RECORDER or MONITOR jack (fig. 8) on the standing wave indicator. If a two-conductor cable assembly is fabricated, a ¼-inch diameter telephone connector plug must be used with the conductors connected to the ring and tip of the connector plug.

c. Connections to INPUT Connector. The cable assembly used to connect the crystal detector output to the INPUT connector on the standing wave indicator (fig. 9) must be fabricated from single-conductor-type RG-58/U shielded cable with a Connector Plug UG-88/U on each end.

15. Initial Adjustments

(fig. 8)

The only initial adjustment required prior to operation is adjusting the pointer on the indicating meter if necessary.

a. Place the METER SCALE switch in either NORMAL or —5DB position.

b. Connect the standing wave indicator to the proper ac power source.

c. Turn the power switch to the ON position and check to see that the LINE POWER indicating light goes on. Allow the standing wave indicator to warm up for 15 minutes.

d. Set the power switch to the off position. Check to see that the LINE POWER indicating light goes off. Observe the meter pointer. If it does not rest at the ∞ mark (at the left of the upper scale), proceed with *e* below.

***Caution:* Do not turn the meter adjusting screw counterclockwise at any time.**

e. Adjust the meter adjusting screw (fig. 8) on the indicating meter while the equipment is still warm. Rotate the meter adjusting screw clockwise (cw) until the meter pointer is traveling counterclockwise (ccw) toward ∞ on the 1 to 4 SWR scale. Stop at ∞ . If the meter pointer travels beyond the ∞ point, continue rotating the meter adjusting screw cw until the meter pointer again approaches ∞ in a ccw direction and stop at ∞ .

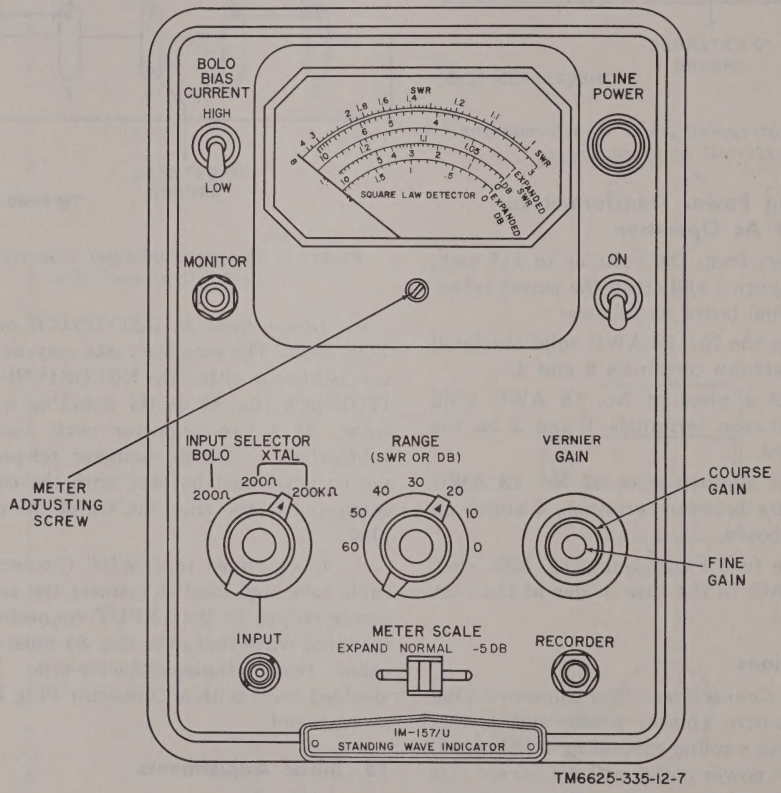


Figure 8. Operating controls and indicators.

CHAPTER 3
OPERATING INSTRUCTIONS

Section I. OPERATOR'S CONTROLS AND INDICATORS

Note. This section describes, locates, and illustrates the controls and instruments provided for the proper operation of the equipment.

16. General

Observe the following precautions when setting the controls:

a. When a barretter-type detector is used, always set the BOLO BIAS CURRENT switch to the LOW position before the power is turned on.

b. Always set the RANGE switch to the 0 position at the start of a test. Advance the RANGE switch one step at a time until the meter indication is obtained.

17. Standing Wave Indicator Operating Controls and Indicators

(fig. 8)

The operating controls and indicators and their functions are as follows:

Control or indicator	Function
BOLO BIAS CURRENT switch	Selects a bias current (from the power supply) to be applied to an external barretter-type detector when used. In the HIGH position, applies 8.4 ma. In the LOW position, applies 4.3 ma.
ON power switch	In the ON position, applies ac power to the standing wave indicator. In the off position, turns off all ac power to standing wave indicator.
LINE POWER indicating light	Lights when power switch is turned ON.
VERNIER GAIN control	Consists of two controls (coarse gain and fine gain) with concentric tuning shafts that adjusts meter indication to full scale or other convenient indication.
RECORDER jack	Provides a means for connecting an external recorder or milliammeter having a 1-ma full-scale deflection and an internal resistance of 1,500 ohms to the standing wave indicator meter circuit.
METER SCALE switch	Selects EXPAND or NORMAL scales on the indicating meter, or shifts meter indication down by −5 db.
RANGE switch	Selects one of seven levels of sensitivity for the signal level being measured. Increases sensitivity by 10, 20, 30, 40, 50, or 60 db.
INPUT connector	Provides a means for connecting the external crystal (or barretter) detector in the slotted line to the standing wave indicator input circuit.
INPUT SELECTOR switch	Selects the proper impedance for the type detector being used. In the BOLO 200 Ω position, selects a 200-ohm impedance to match the impedance of a 200-ohm barretter-type detector. In the XTAL 200 Ω position (normally used with slotted lines), selects a 200-ohm impedance to match the impedance of a 200-ohm crystal detector. In the XTAL 200K Ω position, selects a 200,000-ohm impedance to prevent loading a special crystal detector containing a load resistor which is factory selected to give best square-law response. *Note.* This type detector is not used with slotted lines.
Meter adjusting screw	Provides a means for adjusting the indicating meter pointer.
MONITOR jack	Provides a means for connecting an external milliammeter to the standing wave indicator for monitoring the bias current being applied to an external barretter-type detector.
SQUARE LAW DETECTOR indicating meter	Indicates the voltage standing wave ratio when the standing wave indicator is used with a square law detector in a slotted line. Meter is calibrated to indicate 1 to 4 SWR, 3 to 10 SWR, 1 to 1.3 EXPANDED SWR, 0 to 10 DB, and 0 to 2 EXPANDED DB.

Section II. OPERATION UNDER USUAL CONDITIONS

18. Types of Operation

a. The standing wave indicator together with a suitable slotted line and detector may be used to measure the voltage standing wave ratio and the impedance of any rf load which is fed by coaxial cable or waveguides.

b. For any type operation, perform the following procedures:

(1) Preliminary starting procedure (para 20).

(2) Starting procedure (para 21).

(3) Stopping procedure (para 30).

19. Detector Probe Penetration

a. Generally, when making voltage standing wave ratio measurements, hold the penetration of the detector probe into the slotted line to a minimum. It is important to observe this rule.

b. Rf power absorbed by the detector probe causes distortion in the standing wave pattern. This effect increases as probe penetration increases.

c. Impedance in the standing wave pattern varies along the slotted line. The impedance is at a maximum where the maximum voltages exist in the slotted line and at minimum where the minimum voltages exist. When a probe is inserted into the slotted line, it acts as a shunt and lowers the impedance of the slotted line. This causes the measured voltage standing wave ratio to be lower than the true voltage standing wave ratio and causes the maximum and minimum voltages to shift from their natural positions. The shift is greater at the maximum voltage points in the slotted line than at the minimum voltage points.

d. The probe can cause reflections of rf power which will travel towards the signal generator. These reflections will cause additional errors in the voltage standing wave ratio measurements. The deeper the probe is inserted into the slotted line, the greater the reflections.

20. Preliminary Starting Procedure

Perform the preliminary procedures in *a* through *n* below before starting the equipment as described in paragraph 21. Be sure that the equipment has been properly adjusted (para 15). Figure 9 is a typical test setup for making voltage swr measurements with the standing wave indicator.

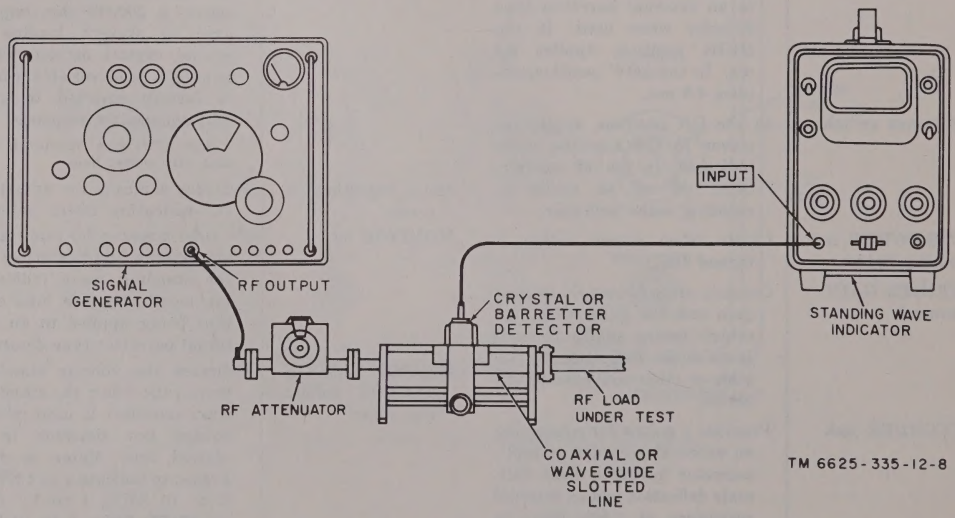


Figure 9. Typical test setup.

a. Set the power ON switch to the off position.

b. Set the BOLO BIAS CURRENT switch to LOW.

c. Set the RANGE switch to 0.

d. Set the METER SCALE switch to NORMAL.

e. Rotate the VERNIER GAIN controls fully counterclockwise.

f. Connect a suitable low-pass filter to the output of the signal generator.

g. Connect a suitable rf attenuator to the output of the low-pass filter.

h. Connect the output of the rf attenuator to the input of the slotted line.

i. Connect the rf load under test to the output of the slotted line.

j. Connect the cable assembly from the detector to the INPUT connector on the standing wave indicator.

k. If a crystal detector is used, set the INPUT SELECTOR switch to the XTAL 200 Ω position. If a barretter detector is used, set the INPUT SELECTOR switch to BOLO 200 Ω.

l. If a barretter detector is used, and the bias current is to be monitored, connect a milliammeter to the INPUT connector (para 28).

m. If the standing wave indicator meter indications are to be recorded, connect the recording milliammeter to the RECORDER connector (para 29).

n. Connect the power cord to the ac line power source.

21. Starting Procedure

Note. If an abnormal indication is obtained during the starting procedure, refer to the operational checklist (para 34) for corrective measures.

To start the equipment, first make sure that the controls are set and the connections made as required by the preliminary starting procedure (para 20), then perform the steps in *a* and *b* below.

a. Set the power switch to ON. Check that the LINE POWER indicator light goes on.

b. Allow the standing wave indicator to warm up for approximately 10 minutes.

22. Measuring Low Standing Wave Ratio (Below 10)

Start the equipment (para 21) and perform the steps below for measuring low standing wave ratio.

a. Tune the signal generator to the specified frequency of the rf load under test. Adjust the signal generator rf output to 0 dbm (decibels referred to 1 milliwatt). Set the signal generator modulator to 1,000 cps square wave modulation. Adjust the rf attenuator for about 6-db attenuation.

b. Set the RANGE switch on the standing wave indicator to 30.

c. Turn the VERNIER GAIN controls clockwise approximately 180°. If there is no meter indication, proceed with *d* below. If a meter indication is obtained, proceed with *e* below.

d. Move the probe carriage along the slotted line to obtain a peak indication on the meter of the standing wave indicator. If the meter goes off scale, reduce the penetration of the detector probe into the slotted line (para 19), reduce the gain of the standing wave indicator by turning the VERNIER GAIN or RANGE controls, or reduce the rf input to the slotted line by means of the rf attenuator. If there is no indication on the meter, adjust the detector probe for a slightly deeper penetration into the slotted line. If there is still no meter indication, set the RANGE switch to 40. If there is still no meter indication, refer to the operational checklist.

e. If a meter indication is obtained in *c* above, adjust the 1,000-cycle modulation frequency of the signal generator for a peak indication on the standing wave indicator meter. If the meter goes off scale, reduce the penetration of the detector probe into the slotted line.

f. If the detector probe is a tunable type, tune it for a peak indication on the standing wave indicator meter. If the meter goes off scale, reduce the penetration of the detector probe into the slotted line.

g. Adjust the VERNIER GAIN coarse and fine gain controls on the standing wave indicator to obtain an exact full-scale indication on the meter. If necessary, adjust the output attenuation level of the signal generator to obtain full-scale meter deflection.

h. Move the probe carriage in the slotted line for a minimum indication (minimum voltage point) on the meter of the standing wave indicator.

i. If the meter indication is between 1.3 and 3 on the 1 to 4 SWR scale (fig. 10, top scale), the standing wave ratio can be read directly from the 1 to 4 SWR scale. If the meter indication is less than 1.3 SWR, proceed with *j below*. If the meter indication is more than 3 on the 1 to 4 SWR scale (dashed line A, fig. 10), set the RANGE switch to the next higher setting and read the meter indication on the 3 to 10 SWR scale (dashed line B, fig. 10). If the meter indication is more than 10, advance the RANGE switch to the next higher setting. Now read the 1 to 4 SWR scale and multiply the reading by 10 to obtain the SWR.

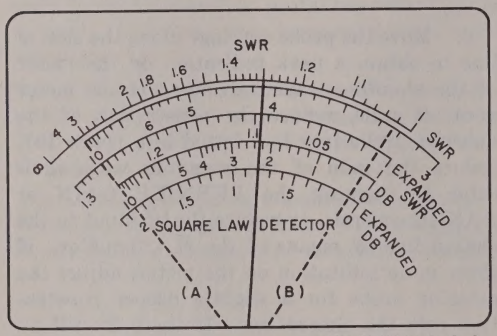


Figure 10. Use of meter scales.

j. If the meter indication is less than 1.3 SWR in *i* above, set the METER SCALE switch to EXPAND and the RANGE switch to 40. Then repeat the steps in *f* through *h* above. Read the meter indication directly on the 1 to 1.3 EXPANDED SWR scale.

23. Reading Standing Wave Ratio in Decibels

Standing wave ratio may also be expressed in decibels as shown from the conversion chart in figure 11. Standing wave ratio may be obtained directly in decibels from the standing wave indicator as follows:

a. Operate the equipment as described in paragraph 22, except read the meter indications on the 0 to 10 DB or the 0 to 2 EXPANDED DB meter scale.

b. If the meter indication is between 5 and 10 db, when reading from the 0 to 10 DB scale set the METER SCALE switch to —5 DB. Read the meter indication from the 0 to 10 DB scale and subtract 5 from the reading obtained.

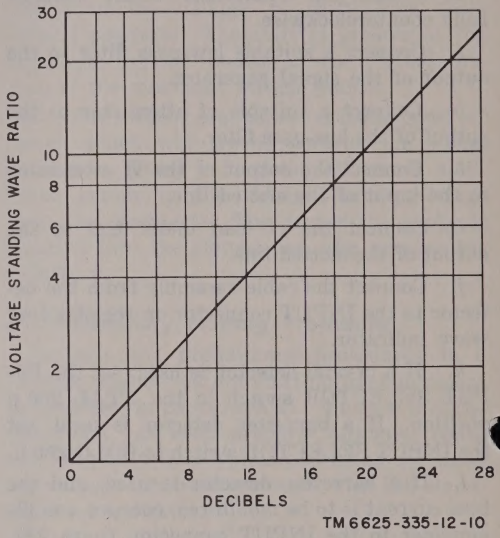


Figure 11. Standing wave ratio to decibels conversion chart.

24. Measuring High Standing Wave Ratio Above 10 (Double Minimum Method)

When measuring a standing wave ratio higher than 10, the conventional methods described in paragraph 22 are generally inaccurate. These inaccuracies exist because the detector probe penetration must be so deep into the slotted line that it will cause reflections due to probe loading in the slotted line as described in paragraph 19. The following method may be used to obtain more accurate standing wave ratio measurements above 10. This method is referred to as the double-minimum method.

a. Repeat steps described in *a* through *f* in paragraph 22.

b. Move the probe carriage along the slotted line to obtain a minimum meter indication on

the standing wave indicator. Record the probe carriage position (in centimeters) on the slotted line.

c. For a reference adjust the VERNIER GAIN coarse and fine gain controls for a meter indication of 3 (this is actually minus 3) on the 0 to 10 DB scale.

Note. In the double minimum method, it is necessary to establish the distance between the points where the probe power output is double the minimum power.

d. Move the probe carriage along the slotted line to obtain a meter indication of zero on the 0 to 10 DB scale. Record the probe carriage position on the slotted line. (Refer to this point as d_1.) Move the probe carriage along the slotted line in the opposite direction until the meter indication is the same as the minimum indication obtained in *b* above. Keep moving the probe carriage in the same direction until a meter indication of zero on the 0 to 10 DB scale is again obtained. Record the probe carriage position on the slotted line. (Refer to this point as d_2.) Measure the distance in centimeters between the probe carriage positions on the slotted line where each of the 0 DB meter indications are obtained (d_2 minus d_1). Record the reading.

e. Replace the rf load with a perfect short circuit (furnished with slotted line equipment). Move the probe carriage along the slotted line until a minimum indication is obtained on the standing wave indicator meter. Record the position of the probe carriage on the slotted line. Move the probe carriage along the slotted line in the opposite direction until a minimum meter indication is again obtained. Record the position of the probe carriage on the slotted line. Compute the distance in centimeters between the positions on the slotted line where each of the minimum meter readings were obtained and multiply the distance by 2. The product is the wavelength of the frequency of the signal generator being used.

f. Figure 12 shows the method for computing the standing wave ratio from the information recorded in *b* through *e* above. In figure 12, *E* MIN represents the minimum meter indication obtained in *b* above; λ_L represents the wavelength of the frequency in use obtained in *e* above, and ΔX represents the centimeter measurement obtained in *d* above. The formula for computing standing wave ratio using the information above is:

$$SWR = \frac{\lambda_L}{\pi (\Delta X)}.$$

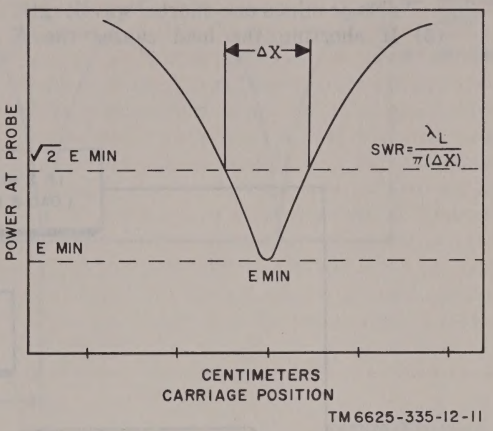


Figure 12. Chart for computing standing wave ratio using double-minimum method.

25. Impedance Measurement Techniques

a. The standing wave indicator and slotted line can be used to measure the impedance characteristic of an rf load such as a transmission system by measuring the position of the voltage minimum with the rf load under test; this establishes a reference point. The load under test is then removed and a shorting load is applied to the slotted line. This causes the voltage minimum to shift. The shift distance information is used to determine the actual rf load impedance.

b. Before going into the actual procedure for measuring impedance, it will be very helpful if the following points illustrated in figure 13 are remembered when using a slotted line and standing wave indicator for impedance measurements.

(1) When the load end of the slotted line is shorted, the *E* minimum will always be a multiple of a half-wavelength from the load.

(2) If shorting the load causes the *E* minimum to shift toward the signal generator, the load has an inductive component.

(3) If shorting the load causes the E minimum to shift toward the load, the load has a capacitive component.

(4) The shift in the E minimum when the load is shorted is never more than plus or minus one-quarter wavelength.

(5) If shorting the load causes the E minimum to shift exactly one-quarter wavelength, the load is completely resistive and is equal to $Z_0 \times SWR$.

(6) If shorting the load does not cause the E minimum to move, the load is completely resistive and is equal to Z_0/SWR.

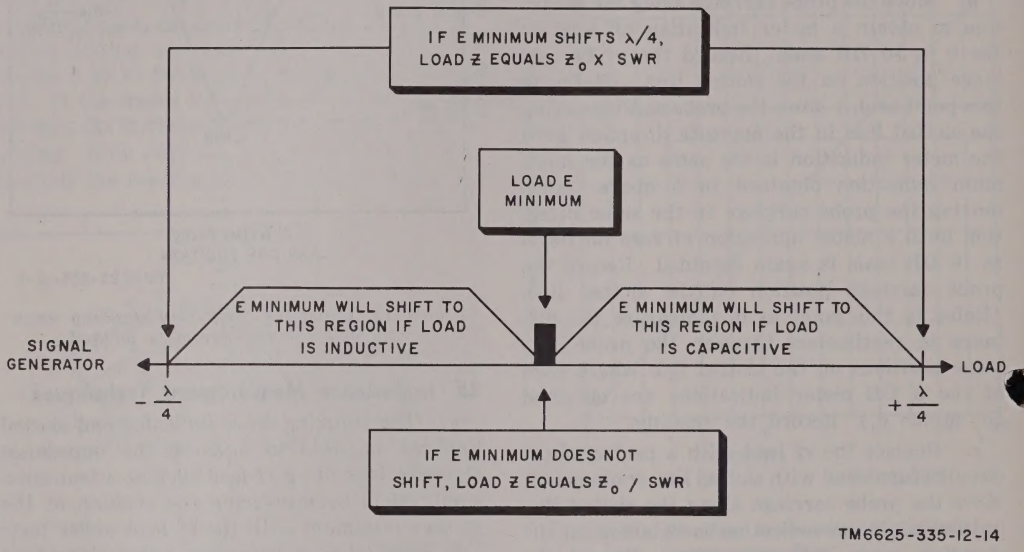


Figure 13. Summary of effects of minimum shift direction.

26. Measuring Rf Load Impedance

(fig. 14)

The standing wave indicator and slotted line may be used to measure the impedance of an rf load as follows:

a. Perform the starting procedures described in paragraph 21.

b. Measure the voltage standing wave ratio as described in paragraph 22.

c. Move the probe carriage along the slotted line until a minimum meter indication is obtained on the standing wave indicator. Record the position (in centimeters) of the probe carriage.

d. Disconnect the rf load from the slotted line and replace it with a short.

Note. A shorting connector is usually furnished with slotted lines.

e. Repeat *c* above and record the new position of the probe carriage on the slotted line.

f. Measure the distance in centimeters between the probe carriage positions recorded in *c* and *e* above. Figure 14 is a graph showing the standing wave patterns with an rf load and with a shorted load. On the figure, *E MIN* represents the minimum meter indications obtained in *c* and *e* above and Δd represents the distance between the two recorded probe carriage positions. Δd is referred to as the minimum shift distance.

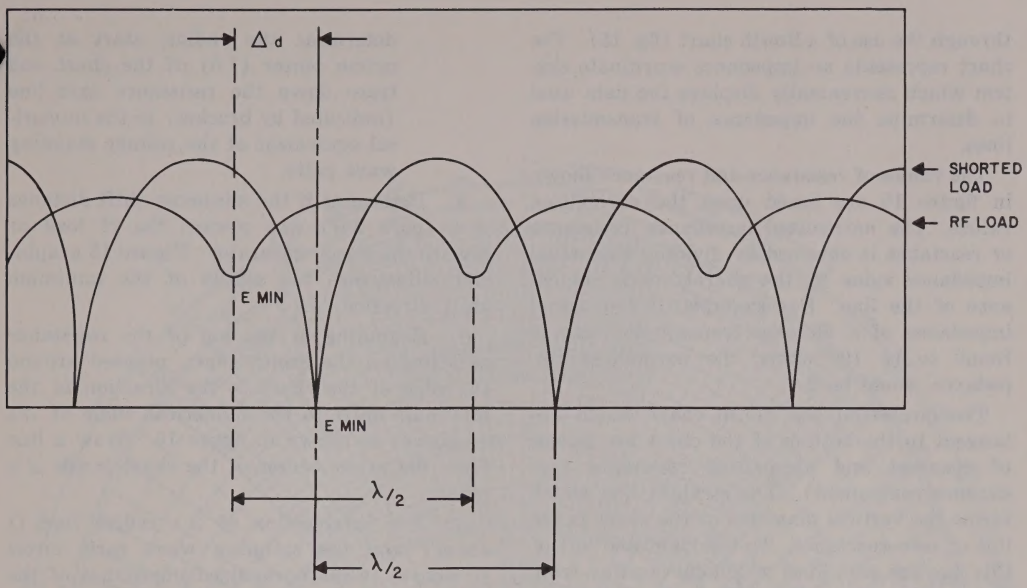


Figure 14. Standing wave patterns with rf load and with shorted load.

g. Starting from the *E* minimum point established in *e* above (for shorted rf load), move the probe carriage along the slotted line until another minimum meter indication is obtained on the standing wave indicator. Record the position of the probe carriage position on the slotted line.

h. Measure the distance in centimeters between the two minimum points on the slotted line found in *e* and *g* above. This measurement is represented on the graph in figure 14 as $\frac{\lambda}{2}$ (shorted load).

i. From the information obtained in *b* through *h* above, the normalized load impedance (Z_L) can be calculated by using a Smith chart as described in paragraph 27, or as follows:

$$Z_L = \frac{1\text{-}j\ (SWR)\ Tan\ X}{(SWR) - j\ Tan\ X}$$

Where: $X = 180° (\pm \Delta d)$

$\frac{\lambda}{2}$

And: $\pm d$ = The minimum shift distance in centimeters between the *E* minimum point with rf load and the minimum point when short is applied as a load. Δd takes a positive (+) sign (capacitive) when the *E* minimum position shifts toward the rf load. Δd takes a negative (—) sign (inductive) when the minimum position shifts toward the signal generator (fig. 13).

And: $\frac{\lambda}{2}$ = One-half wavelength. It is the distance in centimeters measured between two adjacent minimum voltage points on the slotted line.

j. When the normalized impedance has been calculated in *i* above, the actual rf load impedance can be calculated by multiplying the normalized impedance by the characteristic impedance of the slotted line.

Note. These calculations are based on the assumption that no losses occur in the transmission system and that the characteristic impedance of the slotted line is entirely resistive.

27. Impedance Measurement and the Smith Chart

a. General. When data has been obtained from slotted line measurements, the most rapid and simplest method to measure impedance is

through the use of a Smith chart (fig. 15). The chart represents an impedance coordinate system which conveniently displays the data used to determine the impedance of transmission lines.

The values of resistance and reactance shown in figure 15 are based upon the normalized values. The normalized impedance, resistance or reactance is obtained by dividing the actual impedance value by the characteristic impedance of the line. For example, if the actual impedance of a 50 ohm transmission line is found to be 100 ohms, the normalized impedance would be 2.

The circles on the Smith chart which are tangent to the bottom of the chart are circles of constant and normalized resistance (resistance component). The straight line which forms the vertical diameter of the chart is the line of zero reactance. To the right and left of this line are seen lines which curve away from the zero reactance line. The curved lines to the right are lines of positive reactance. The curved lines to the left are lines of negative reactance.

The impedance point of a transmission line terminated by its characteristic impedance would be the prime center of the chart with a normalized resistance of 1.0 and no reactive component.

b. Procedure for Calculating Impedance, Using Smith Chart.

(1) Perform the impedance measurements described in paragraph 26 and the SWR measurement described in paragraph 22.

(2) Determine the wavelength of the transmission line by multiplying the $\frac{\lambda}{2}$ measurement obtained in paragraph 26*h* by 2. The product is λ_L.

(3) Determine the wavelength of the minimum shift distance by dividing the minimum shift distance Δd obtained in paragraph 26*f* by the transmission line wavelength λ_L obtained in *b* above. (i.e. $\Delta \lambda = \frac{\Delta d}{\lambda_L}$).

(4) Starting at the center of a Smith chart, draw a circle with the SWR as the radius as shown in figure 15. To determine the radius, start at the prime center (1.0) of the chart and trace down the resistance axis line (indicated by bracket) to the numerical equivalent of the voltage standing wave ratio.

e. Determine if the minimum shift distance Δd (para 26*f*) was toward the rf load or toward the signal generator. Figure 13 graphically illustrates the effects of the minimum shift direction.

f. Beginning at the top of the resistance axis line on the Smith chart, proceed around the edge of the chart in the direction of the minimum shift to the numerical value of $\Delta \lambda$ (*c* above) as shown in figure 16. Draw a line from the prime center of the chart to the $\Delta \lambda$ point.

g. The intersection of $\Delta \lambda$ radius line (*f* above) and the standing wave ratio circle (*d* above) is the normalized impedance of the rf load as shown in figure 17. For example: assume that the SWR is 3.3; Δd is 3 centimeters and λ_L is 30 centimeters. The minimum shift distance wavelength, $\Delta \lambda$ would be calculated as follows:

$$\Delta \lambda = \frac{\Delta d}{\lambda_L} = \frac{3}{30} = 0.1 \text{ wavelength.}$$

The Smith chart would be constructed as shown in figure 17. The normalized impedance would be .44 + jo.64 as obtained at point "A" on the chart.

h. To calculate the actual impedance, multiply the normalized impedance obtained above by the characteristic impedance of the slotted line.

i. For example, assume that in *g* above the transmission line used was a coaxial line with a characteristic impedance of 50 ohms, the actual impedance would be found by multiplying the normalized impedance by 50. The actual solution is as follows:

$$Z_a = Z_L \times Z_o$$

Where Z_a = actual impedance

Z_L = normalized impedance

Z_o = characteristic impedance

Hence

$$Z_a = .44 + jo.64 \times 50$$

$$Z_a = \sqrt{(.44)^2 + (.64)^2} \times 50$$

$$Z_a = 38.5 \text{ ohms}$$

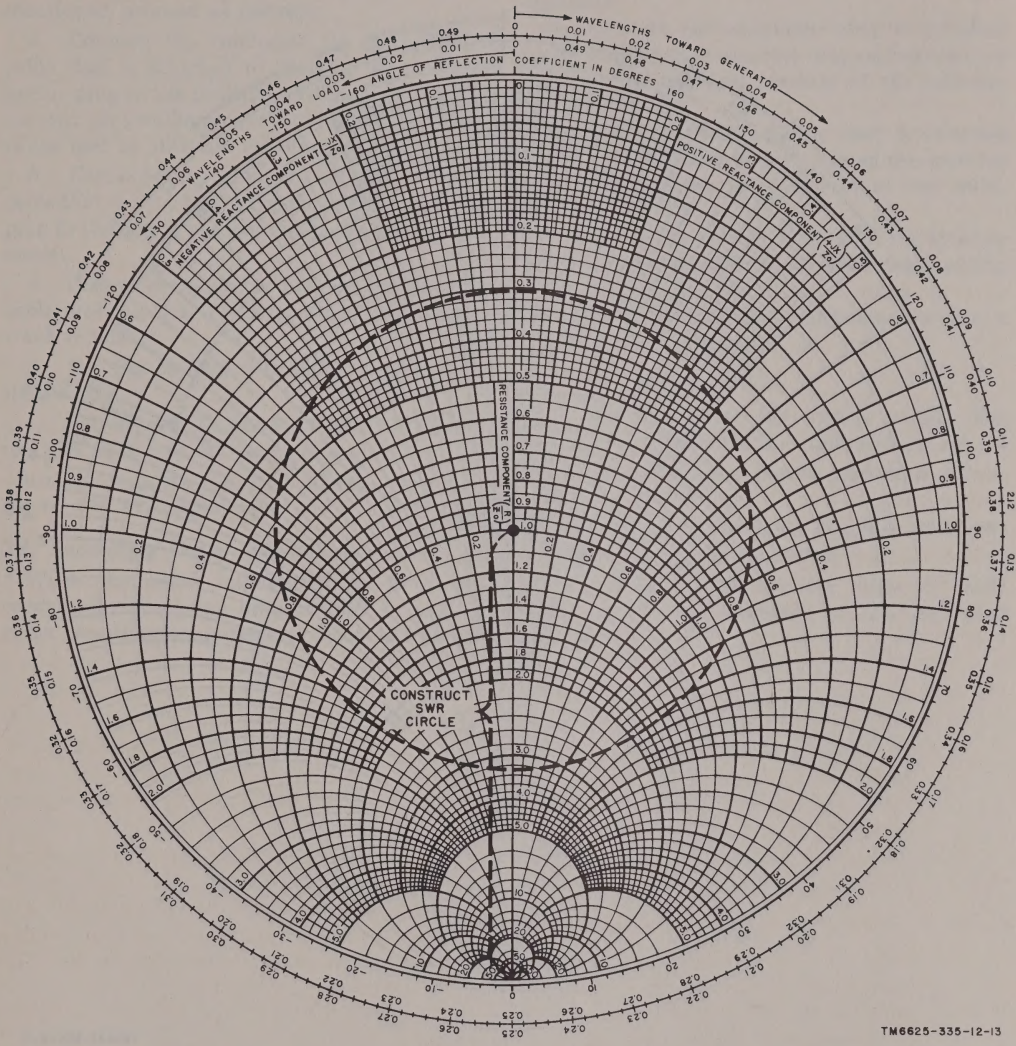


Figure 15. Smith chart showing typical construction of SWR circle.

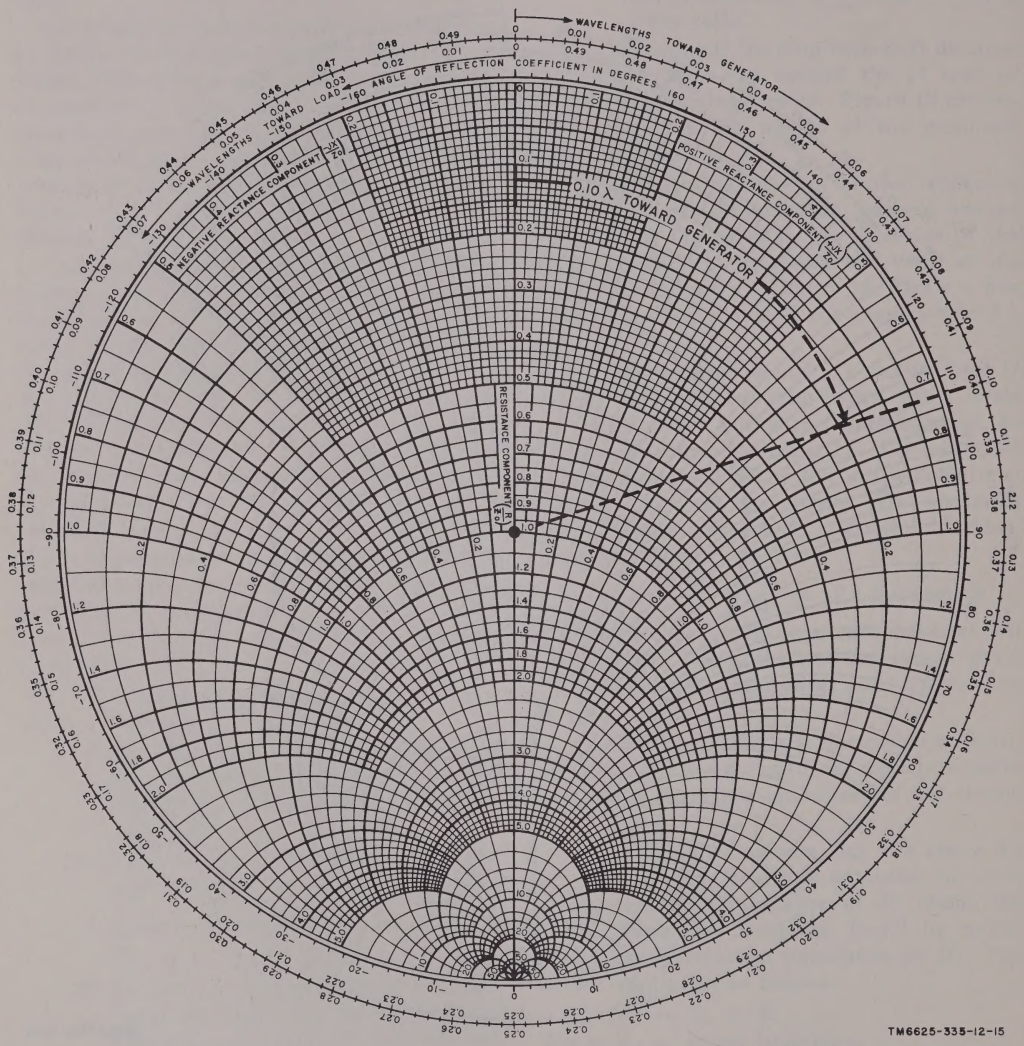


Figure 16. Smith chart showing typical minimum shift point wavelength constructed as radius.

28. Monitoring Bias Current of Barretter Detectors

When a barretter type detector (bolometer) is being used, and the bias current is to be monitored, proceed as follows:

a. Connect the conductor of the monitor cable that is attached to the ring of the connector plug to the positive terminal of a direct-current (dc) milliammeter having a 0- to 10-ma range and an internal resistance of 20 ohms.

b. Connect the conductor of the monitor cable that is attached to the tip of the connector plug to the negative terminal of the dc milliammeter.

c. Insert the connector plug on the monitor cable into the MONITOR jack on the standing wave indicator.

d. Set the INPUT SELECTOR switch to BOLO 200Ω.

e. Set the BOLO BIAS CURRENT switch to LOW (4.3 ma) or HIGH (8.4 ma).

Note. The manufacturer of the barretter will specify the value of bias current used.

29. Recording Meter Indications

When the meter indications are to be recorded on a recording milliammeter or similar chart recording equipment, proceed as follows:

a. Make sure that the recording milliammeter has an internal resistance of 1,500 ohms.

b. Use the monitor cable to connect the recording milliammeter to the standing wave indicator.

c. Connect the conductor that is attached to the ring of the connector plug on the monitor cable to the positive terminal of the milliammeter.

d. Connect the conductor that is attached to the tip of the connector plug on the monitor cable to the negative terminal of the milliammeter.

e. Insert the connector plug on the monitor cable into the RECORDER jack on the standing wave indicator.

f. Set the recording milliammeter for a 1-ma full-scale deflection.

30. Stopping Procedure

a. Set the power ON switch to off. The LINE POWER indicating light will go out.

b. Disconnect the power cord from the ac power source.

c. Disconnect the cable assembly from the INPUT front panel connector.

d. Disconnect the monitor cable (if used) from the dc milliammeter or the recording milliammeter.

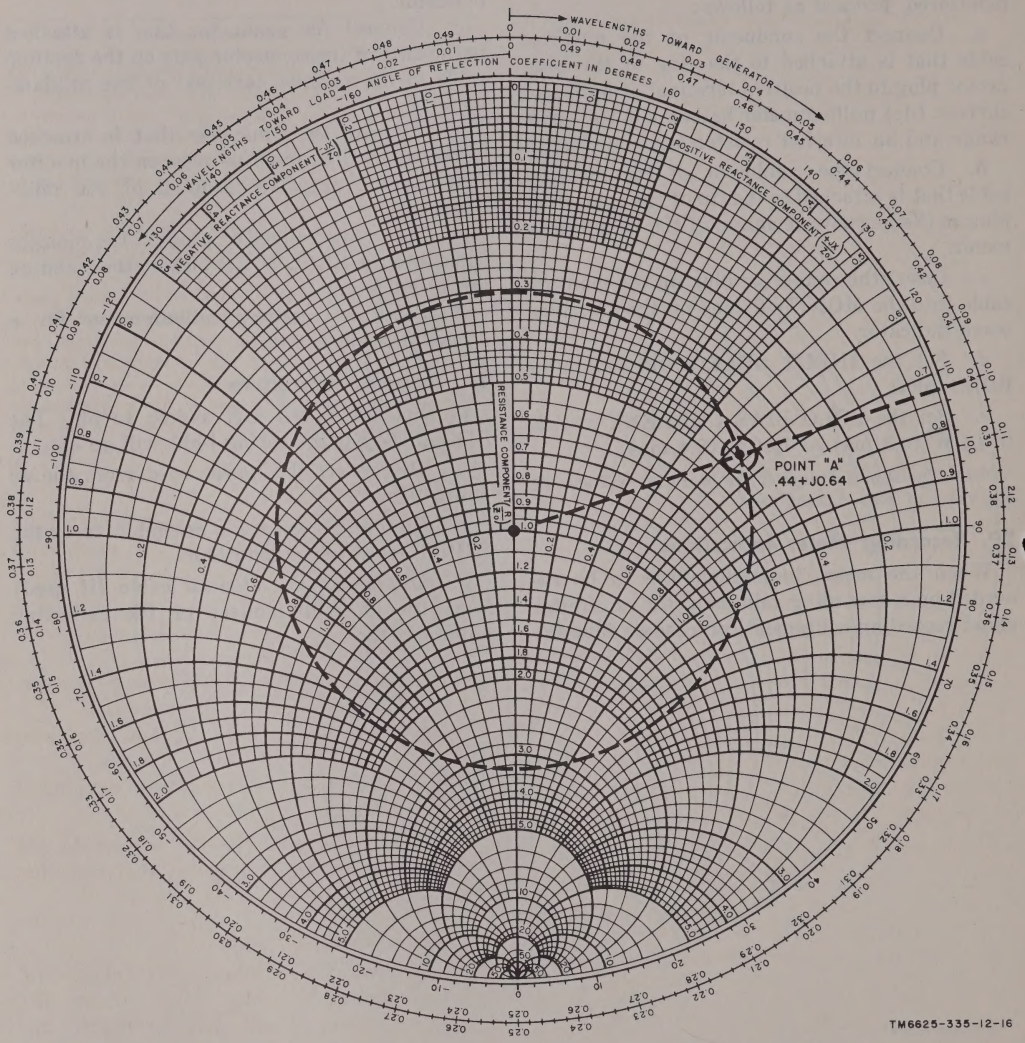


Figure 17. Smith chart showing typical impedance point.

CHAPTER 4

OPERATOR'S MAINTENANCE

31. Scope of Operator's Maintenance

a. The following is a list of maintenance duties normally performed by the operator of the AN/UPM-108. These procedures do not require special tools or test equipment.

b. Operator's maintenance for the AN/UPM-108 consists of the following:

(1) Preventive maintenance (para 32).
(2) Visual inspection (para 33).
(3) Operational checklist (para 34).
(4) Replacement of defective indicating light (para 35*a*).
(5) Replacement of defective fuse (para 35*b*).
(6) Replacement of monitor cable.

32. Preventive Maintenance

a. DA Form 11-266. DA Form 11-266 (fig. 18 and 19) is a preventive maintenance checklist to be used by the operator. Items not applicable to the standing wave indicator are lined out. Reference in the ITEM block in the figures are to paragraphs that contain additional maintenance information pertinent to the particular item. Follow the instructions on the form.

b. Items. The information shown in this paragraph supplements DA Form 11-266. The item numbers correspond to the ITEM numbers on the form.

Item	Maintenance procedures
1	Use a clean cloth to remove dust, dirt, moisture, and grease from the housing, front panel, and meter glass. If necessary, wet the cloth with Cleaning Compound (Federal stock No. 7930-395-9542) and then wipe the parts dry with a dry, clean cloth.
2	Tighten the setscrew in any loose knob. ***Caution*: Never tighten the VERNIER GAIN outer concentric knob (coarse gain) setscrews excessively. This will pinch the outer shaft and cause it to bind on the inner shaft. This in turn, causes interaction between the fine and coarse VERNIER GAIN controls. Tighten the two setscrews a little more than "finger tight."**
3	All control knobs should work smoothly, be tight on the shafts, and should not bind. If any knob rubs against the panel, loosen the setscrew and pull the knob away from the panel approximately one-eighth inch and retighten the setscrew (observe caution in item 2).
5	Repair any cuts in the power-cord insulation by covering them with rubber tape and then with friction tape.
11	Check the meter for broken or cracked glass. See that the mounting screw in each of the four corners of the meter case is tight. See that the meter case is not cracked or broken.

***Warning*: Cleaning compound is flammable and its fumes are toxic. Do not use it near a flame; provide adequate ventilation.**

33. Visual Inspection

a. When the standing wave indicator fails to perform properly, turn off the power and check all the items listed below. *Do not check any item with the power on.*

(1) Wrong settings of switches and controls (para 22).
(2) Input and output cable assemblies disconnected or poorly connected.
(3) Burned-out fuse (usually indicates some other fault).
(4) Associated external test equipment defective.

b. If the above checks do not locate the trouble, proceed to the operational checklist (para 34).

34. Operational Checklist

a. General. The operational checklist will help the operator to locate trouble quickly. The corrective measures are used to repair this trouble. If the measures suggested do not restore normal equipment performance, troubleshooting is required by an instrument repairman. Note on the repair tag what corrective measures were taken and how the equipment performed at the time of failure.

b. Procedure. Perform the preliminary starting procedures described in paragraph 20,

MAINTENANCE CHECK LIST FOR SIGNAL EQUIPMENT
TEST EQUIPMENT
(AR 750-625)

EQUIPMENT NOMENCLATURE

INDICATOR, STANDING WAVE RATIO AN/UPM-108

EQUIPMENT SERIAL NUMBER

25

INSTRUCTIONS

This form may be used for a period of one month by using the correct dates and weeks of the month. It is to be used as a Preventive Maintenance check list for Signal equipment in actual use, or for a check on equipment prior to issue.

1. For detailed Preventive Maintenance instructions see:
   a. The Technical Manual *(in TM 11 series)* for the equipment. *(See DA Pamphlet Number 310-4)*
   b. The Supply Bulletin *(SB 11-100 series)* for the equipment. *(See DA Pamphlet Number 310-4)*
   c. The Department of the Army Lubrication Order. *(See DA Pamphlet Number 310-4)*

2. The following action will be taken by either the Communications Officer/ Chief for 1st echelon, or the Inspector for higher echelon:
   a. Enter Equipment Nomenclature and Serial Number.
   b. Strike out items that do not apply to the equipment.

3. Operator/Inspector will enter in the columns entitled CONDITION, on the proper line, a notation regarding the condition, using symbols specified under LEGEND.

4. After operator completes each daily inspection he will initial over the appropriate dates under "Daily Condition for Month", then return form to his supervisor.

FOLD

TYPE OF INSPECTION

OPER-ATOR	2/3 ECH-ELON	DATE	SIGNATURE
✓		6 MAY '60	Paul Hughes

U. S. GOVERNMENT PRINTING OFFICE: 1957 O—427138

4

DA FORM 1 MAY 57 11-266

Figure 18. DA Form 11-266, pages 1 and 4.

LEGEND for marking conditions:
Satisfactory, ✓.
Adjustment, Repair or Replacement required, X.
Defect corrected, (X).

DAILY CONDITION FOR MONTH OF MAY 1960

NO.	DAILY ITEM	1 PH 17	2 PH 18	3 PH 19	4 PH 20	5 PH 21	6 PH 22	7 23	8 24	9 25	10 26	11 27	12 28	13 29	14 30	15 31	16	2D 3D ECHELON
1.	CLEAN DIRT AND MOISTURE FROM EXPOSED SURFACES OF HOUSINGS, ~~CASES, CABINETS, CONTROL PANELS,~~ INTERCONNECTING PLUGS, CABLES, ~~HEADSETS,~~ METER WINDOWS, ETC. PARA 32	✓	✓	✓	✓	✓	✓											
2.	INSPECT FOR LOOSENESS OF EXTERIOR ITEMS SUCH AS SWITCHES, KNOBS, ~~JACKS,~~ CONNECTORS AND PILOT LIGHTS. PARA 33	✓	✓	✓	✓	✓	✓											
3.	INSPECT CONTROLS FOR BINDING, SCRAPING. TAP CONTROLS LIGHTLY FOR CUT-OUT DUE TO LOOSE CONTACTS. PARA 32	✓	✓	✓	✓	✓	✓											
4.	DURING OPERATION BE ALERT FOR ANY UNUSUAL PERFORMANCE OR CONDITION. PARA 34	✓	✓	✓	✓	✓	✓											

WEEKLY	CONDITION EACH WEEK 1ST	2D	3D	4TH	5TH	2D 3D ECH
5. INSPECT CORDS, CABLES, ~~WIRE AND SHOCK MOUNTS~~ FOR BREAKS, CUTS, KINKS, DETERIORATION, STRAIN AND FRAYING. PARA 32	✓					
6. ~~INSPECT CANVAS AND LEATHER ITEMS FOR FUNGUS, FRAYING, TEARS, BROKEN ZIPPERS AND SNAP FASTENERS.~~						
7. HAND CHECK FOR LOOSENESS OF EXTERIOR ITEMS SUCH AS HANDLES, LATCHES, HINGES.	X					
8. ~~INSPECT FOR LUBRICATION IN ACCORDANCE WITH APPLICABLE DA LUBRICATION ORDER.~~						
9. ~~INSPECT DRY BATTERIES FOR DIRT, LOOSE TERMINALS AND LEAKAGE.~~						
10. INSPECT EXPOSED METAL SURFACES FOR RUST AND CORROSION.	✓					
11. INSPECT METERS FOR DAMAGED GLASS AND CASES. PARA 32	✓					

ADDITIONAL ITEMS FOR 2D AND 3D ECHELON INSPECTIONS	CONDITION
12. INSPECT SEATING OF READILY ACCESSIBLE ITEMS OF A PLUG-OUT NATURE: CRYSTALS, FUSES, CONNECTORS, PLUG-IN COILS, LAMPS, ETC. DO NOT REMOVE, ROCK OR TWIST TO INSPECT. USE ONLY A DIRECT PRESSURE TO INSURE THE ITEM IS FULLY SEATED.	
13. INSPECT FOR CLEANLINESS AND TIGHTNESS OF SUCH ITEMS AS SHOCK MOUNTS, ANTENNA, ANTENNA MOUNTS AND WAVE GUIDES.	
14. INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR DIRT, CORROSION, WORN OR BURNED CONTACTS.	

ADDITIONAL ITEMS FOR 2D AND 3D ECHELON INSPECTIONS	CONDITION
15. INSPECT RESISTORS, BUSHINGS, INSULATORS FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE.	
16. INSPECT JACKS AND CONNECTORS FOR SNUG FIT AND GOOD CONTACTS.	
17. INSPECT VARIABLE CAPACITORS FOR DIRT AND MOISTURE.	
18. INSPECT AIR FILTERS FOR CLEANLINESS.	
19. INSPECT SCREWTYPE TERMINALS OF TRANSFORMERS, FIXED CAPACITORS, RESISTORS, CHOKES, POTENTIOMETERS AND RHEOSTATS FOR CORROSION, DIRT AND LOOSE CONTACTS.	
20. CLEAN AND TIGHTEN SWITCHES, BLOWERS, RELAY CASES; CLEAN INTERIOR OF CHASSIS AND CABINETS.	
21. INSPECT GENERATORS, MOTORS AND DYNAMOTORS FOR BRUSH WEAR, SPRING TENSION, ARCING AND COMMUTATOR WEAR.	
22. INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.	
23. INSPECT GASKETS AND BUSHINGS FOR WEAR AND DAMAGE.	
24. INSPECT CATHODE RAY TUBES FOR BURNED SCREEN SPOTS.	
25. BEFORE STORING OR SHIPPING REMOVE ALL BATTERIES.	

IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING THE INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. *(Continue on page 4, if more space is needed)*

ITEM 7. HANDLE BROKEN. REPORTED TO 2D ECHELON MAINTENANCE FOR REPAIR.

2 3

Figure 19. DA Form 11-266, pages 2 and 3, as used by operator.

except connect a shorting connector across the end of the slotted line in place of the rf load. Perform the steps in *c* below, in the order given. Observe the equipment operation and perform any corrective measures necessary.

Note. When making the tests described in *c* below, always check the external test equipment and cable assembly connections before troubleshooting the standing wave indicator and making extensive repairs.

c. Operational Checklist.

Action	Normal indication	Corrective measure
Set the power switch to ON.	LINE POWER indicating light goes on.	Check indicator light (para 35*a*). Check fuse F1 in rear panel. Check connector plug on power cable. Check strapping on power transformer (para 12 or 13).
Turn on the associated signal generator. Adjust rf output of the signal generator to approximately 0 dbm (1 milliwatt). Adjust the output to the desired frequency. Adjust the square wave modulation frequency to 1,000 cps. Tune the crystal detector (if it is a tunable type). Set the RANGE switch on the standing wave indicator to 50 and turn the VERNIER GAIN coarse and fine gain controls approximately 180° cw. Set the INPUT SELECTOR to XTAL–200 Ω.	An indication should be obtained on the meter of the standing wave indicator.	See that the RANGE switch is at 50. See that the crystal detector is tuned to the rf signal frequency (if it is a tunable type) and probe penetration into slotted line is sufficient. See that the signal generator is being square-wave modulated at exactly 1,000 cps. See that sufficient rf power is being fed into the slotted line from the signal generator. See that the crystal detector is not defective. Check for open or shorted cable from crystal detector to standing wave indicator.
Adjust the modulation frequency control of the signal generator for maximum deflection of the standing wave indicator meter.	The meter deflects clockwise as the modulation frequency approaches 1,000 cps. There should be little or no meter deflection when the modulation frequency is 30 cps above or below resonance.	Higher echelon repair is required.

35. Repairs and Adjustment

a. Replacement of LINE POWER Incandescent Lamp.

(1) Turn the lens counterclockwise and remove it from the lampholder in the front panel.

(2) Press in on the defective lamp and turn it counterclockwise to unlock it from the lampholder.

(3) Insert the new lamp into the lampholder. Press in on the lamp and turn it clockwise to lock it.

(4) Replace the lens on the lampholder and turn it clockwise to tighten it.

b. Replacement of Fuse.

(1) Turn the fuseholder cap counterclockwise and remove it from the body of the fuseholder.

(2) Remove the defective fuse from the fuseholder cap.

(3) Insert a new fuse in the fuseholder cap.

Note. Be sure fuse is a "slow blow" type of proper rating (1 amp 250v for 115V and ½ amp for 230V operation).

(4) Replace the fuseholder cap in the fuseholder body and turn it clockwise to tighten it.

CHAPTER 5

ORGANIZATIONAL MAINTENANCE

Section I. MAINTENANCE

36. Scope of Unit Repairman's Maintenance

a. Second echelon maintenance duties are listed in *b* below. Their scope is determined by the available tools, materials, test equipment, and spare parts available.

b. Second echelon maintenance of the standing wave indicator consists of the following:

(1) Replacement of Connector, Plug, Electrical UP-121M.
(2) Preventive maintenance (para 38).
(3) Bumper, rubber replacement.
(4) Visual inspection (para 39).
(5) Replacement of cap, electrical (fuseholder).
(6) Troubleshooting (para 40).
(7) Replacement of all handles, switch.
(8) Replacement of defective tubes (para 41).
(9) Replacement of all knobs.
(10) Replacement of 1,000-cps filter Z1 (para 42).
(11) Replacement of lens for indicator light.
(12) Replacement of electron tube shields.

37. Tools, Materials, and Test Equipment Required

The tools, materials, and test equipment required for second echelon maintenance are listed below.

a. Tools. Tool equipment normally available to second echelon.

b. Materials.

(1) Cleaning Compound (Federal stock No. 7930-395-9542).
(2) Cleaning cloth.

***Warning*: Cleaning compound is flammable and its fumes are toxic. Do not use it near a flame; provide adequate ventilation.**

c. Test Equipment. Electron Tube Test Set TV-7/U.

38. Preventive Maintenance

a. DA Form 11-266. DA Form 11-266 (fig. 20) is a preventive maintenance checklist to be used by the second echelon. Items not applicable to the equipment are lined out. References to the ITEM block in the figure are to paragraphs that contain additional maintenance information pertinent to the particular item. Additional preventive maintenance information concerning items 1, 2, 3, 5, and 11 on DA Form 11-266 will be found in paragraph 32. Follow the instructions on the form.

b. Items. The information shown in this subparagraph is supplementary to DA Form 11-266. The item numbers correspond to the ITEM numbers on the form.

***Warning:* Disconnect all power before performing the following operations. After power is disconnected, some capacitors still may retain dangerous voltages. Before touching exposed electrical parts, short-circuit the parts to ground. When maintenance is completed, replace the equipment in its case, and check for satisfactory operation as described in paragraph 34.**

Item	Maintenance procedures
12	See that plug-in 1,000-cps filter Z1 is seated firmly in its socket. See that the screw and nut on the attaching clamp are tight. Check the filter case for cracks. See that the tube shield on tube V1 is secure.
15	Check the loop clamps that support some capacitors and resistors for evidence of damage. See that the parts are secure in the clamps. Tighten the attaching screws.
20	See that the springs on the rotary switches are secure and are not broken or otherwise defective.

LEGEND for marking conditions:
Satisfactory, ✓.
Adjustment, Repair or Replacement required, X.
Defect corrected, (X).

DAILY CONDITION FOR MONTH OF

MAY 1960

NO.	DAILY ITEM	1 17	2 18	3 19	4 20	5 21	6 22	7 23	8 24	9 25	10 26	11 27	12 28	13 29	14 30	15 31	16	2D ~~3D~~ ECHELON
1.	CLEAN DIRT AND MOISTURE FROM EXPOSED SURFACES OF HOUSINGS, ~~CASES, CABINETS, CONTROL PANELS,~~ INTERCONNECTING PLUGS, CABLES, ~~HEADSETS,~~ METER WINDOWS, ETC.																	✓
2.	INSPECT FOR LOOSENESS OF EXTERIOR ITEMS SUCH AS SWITCHES, KNOBS, ~~JACKS,~~ CONNECTORS AND PILOT LIGHTS.																	✓
3.	INSPECT CONTROLS FOR BINDING, SCRAPING. TAP CONTROLS LIGHTLY FOR CUT-OUT DUE TO LOOSE CONTACTS.																	✓
4.	DURING OPERATION BE ALERT FOR ANY UNUSUAL PERFORMANCE OR CONDITION.																	✓

WEEKLY	CONDITION EACH WEEK 1ST	2D	3D	4TH	5TH	2D ~~3D~~ ECH
5. INSPECT CORDS, CABLES, WIRE ~~AND SHOCK MOUNTS~~ FOR BREAKS, CUTS, KINKS, DETERIORATION, STRAIN AND FRAYING.						X
6. ~~INSPECT CANVAS AND LEATHER ITEMS FOR FUNGUS, FRAYING, TEARS, BROKEN ZIPPERS AND SNAP FASTENERS.~~						
7. HAND CHECK FOR LOOSENESS OF EXTERIOR ITEMS SUCH AS HANDLES, LATCHES, HINGES.						✓
8. ~~INSPECT FOR LUBRICATION IN ACCORDANCE WITH APPLICABLE LO LUBRICATION ORDER.~~						
9. ~~INSPECT DRY BATTERIES FOR DIRT, LOOSE TERMINALS AND LEAKAGE.~~						
10. INSPECT EXPOSED METAL SURFACES FOR RUST AND CORROSION.						✓
11. INSPECT METERS FOR DAMAGED GLASS AND CASES.						✓

ADDITIONAL ITEMS FOR 2D AND 3D ECHELON INSPECTIONS	CONDITION
12. INSPECT SEATING OF READILY ACCESSIBLE ITEMS OF A PLUCK-OUT NATURE: CRYSTALS, FUSES, CONNECTORS, ~~PLUG-IN COILS,~~ LAMPS, ETC. DO NOT REMOVE, ROCK OR TWIST TO INSPECT. USE ONLY A DIRECT PRESSURE TO INSURE THE ITEM IS FULLY SEATED.	✓
13. ~~INSPECT FOR CLEANLINESS AND TIGHTNESS OF SUCH ITEMS AS SHOCK MOUNTS, ANTENNA, ANTENNA MOUNTS AND WAVE GUIDES.~~	
14. ~~INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR DIRT, CORROSION, WORN OR BURNED CONTACTS.~~	

ADDITIONAL ITEMS FOR 2D AND 3D ECHELON INSPECTIONS	CONDITION
15. INSPECT RESISTORS, ~~BUSHINGS, INSULATORS~~ FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE.	✓
16. INSPECT JACKS AND CONNECTORS FOR SNUG FIT AND GOOD CONTACTS.	✓
17. ~~INSPECT VARIABLE CAPACITORS FOR DIRT AND MOISTURE.~~	
18. ~~INSPECT AIR FILTERS FOR CLEANLINESS.~~	
19. INSPECT ~~SCREWTYPE~~ TERMINALS OF TRANSFORMERS, FIXED CAPACITORS, RESISTORS, ~~CHOKES, POTENTIOMETERS AND RHEOSTATS~~ FOR CORROSION, DIRT AND LOOSE CONTACTS.	✓
20. CLEAN AND TIGHTEN SWITCHES, ~~BLOWERS, RELAY CASES;~~ CLEAN INTERIOR OF CHASSIS AND CABINETS.	✓
21. ~~INSPECT GENERATORS, MOTORS AND DYNAMOTORS FOR BRUSH WEAR, SPRING TENSION, ARCING AND COMMUTATOR WEAR.~~	
22. ~~INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.~~	
23. ~~INSPECT GASKETS AND BUSHINGS FOR WEAR AND DAMAGE.~~	
24. ~~INSPECT CATHODE RAY TUBES FOR BURNED SCREEN SPOTS.~~	
25. ~~BEFORE STORING OR SHIPPING REMOVE ALL BATTERIES.~~	

IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING THE INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. *(Continue on page 4, if more space is needed)*

ITEM 5. DEFECTIVE CABLE, POWER, ELECTRICAL. REPORTED TO HIGHER MAINTENANCE ECHELON.

2 3

Figure 20. DA Form 11–266, pages 2 and 3, as used by second echelon.

Section II. TROUBLESHOOTING

39. Visual Inspection

Before operating the standing wave indicator, inspect it. Inspection will save repair time and may also avoid further damage. Inspect the following obvious defects:

a. The seating of all tubes and 1,000-cps filter Z1 in their sockets.

b. Wiring connections on the terminal boards.

c. The strapping on the power transformer terminal board (para 12 or 13).

d. Wiring connections to the switches and connectors.

40. Equipment Performance Checklist

a. General. The equipment performance checklist provides a procedure for systematically checking the equipment performance. All corrective measures that the second echelon repairman can perform are given in the "Corrective measures" column. When using the checklist, start at the beginning and follow each step in sequence. If the corrective measures indicated do not fix the equipment, troubleshooting is repaired by higher echelon. Note on the repair tag how the equipment performed and the corrective measures that were taken.

b. Procedure. Place the standing wave indicator in operation as shown in the checklist in *c* below.

c. Equipment Performance Checklist.

	Step	Action	Normal indication	Corrective measures
PREPARATORY	1	Set the power ON switch to the off position. Set the RANGE switch to 40. Set the BOLO BIAS CURRENT switch to LOW. Set the METER SCALE switch to NORMAL. Set the VERNIER GAIN controls to their mid positions. Set the INPUT SELECTOR switch to XTAL-200Ω if a crystal detector is being used, or BOLO 200Ω if a barretter is being used.		
	2	Connect the detector output from the slotted line to the INPUT connector on the standing wave indicator.		
	3	Connect a short across the load end of the slotted line.		
	4	Connect the signal generator (equipped with a low-pass filter) and an rf attenuator to the slotted line. Turn on the signal generator and tune it to a convenient operating frequency. Set the modulating frequency of the signal generator to 1,000 cps square wave.		

	Step	Action	Normal indication	Corrective measures
START	5	Connect the power cord to the power source and set the power switch to ON.	LINE POWER indicator light goes on. Meter deflects clockwise after not more than 2 minutes.	Check fuse F1. Check the power cord and its connector plug. See that the RANGE switch is at 40. See that the detector is tuned to the rf signal frequency (if it is tunable type). See that the signal generator is being square-wave modulated at exactly 1,000 cycles per second. See that sufficient rf power is being fed into the slotted line (more than 0.1 mw). See that probe penetration into slotted line is sufficient. Check that the crystal or barretter detector is not defective. Check for open or shorted cable from detector to standing wave indictor.
EQUIPMENT PERFORMANCE	6	Turn the VERNIER GAIN controls to the point that gives the highest meter indication. If there is no meter indication, adjust the modulation frequency on the signal generator for maximum meter deflection, tune the probe if it is tunable, adjust the detector probe for a deeper penetration in the slotted line (para 19).	The meter should give an indication.	Check tubes V1, V2, and V3 (para 41). Replace 1,000-cps filter Z1 (para 43) and repeat the test. If there still is no meter indication, reinstall the original filter (Z1) and forward the equipment to higher echelon for repair.
	7	Adjust the modulation frequency of the associated signal generator for a peak indication on the standing wave indicator meter. If the meter goes off-scale, reduce the penetration of the detector probe in the slotted line (para 19), reduce the gain of the standing wave indicator, or reduce signal strength of the rf input to the slotted line.	Meter indication should peak at 1,000 cps ±20 cps.	Replace 1,000-cps filter Z1 (para 43).
	8	Move the probe carriage along the slotted line.	As the probe carriage is moved, the standing wave indicator meter should fluctuate over a wide area.	Check tubes V1, V2, and V3 (para 41). If replacing tubes does not correct the fault, higher echelon maintenance is required.

	Step	Action	Normal indication	Corrective measures
EQUIPMENT PERFORMANCE	9	Connect a dc milliammeter to the MONITOR jack (para 28). Set the BOLO BIAS CURRENT switch to LOW, then set the switch to HIGH. *Note.* This test can only be performed if a 8.4-ma barretter detector is being used with the slotted line.	With the BOLO BIAS CURRENT switch set to LOW, the dc ammeter should read 4.3 ma. With the switch set to HIGH, the dc ammeter should read 8.4 ma. ***Caution:* Do not throw switches to HIGH position if a 4.3-ma type barretter is being used.**	Higher echelon maintenance required.

41. Tube-Testing Techniques

When trouble occurs in the standing wave indicator, check all external cabling and connections before removing any tubes. Almost all troubles with the standing wave indicator will be caused by weak, gassy, or noisy tubes. If tube failure is suspected, use the applicable procedure below to check the tubes.

Cautions:

1. Do not rock or rotate a tube when removing it from a socket; pull it straight out with a tube puller.

2. Do not disturb any wires in the instrument, especially those around the RANGE switch. All black wires should be kept away from all resistors in the RANGE switch. Improperly positioned wires on the RANGE switch can change the range to range calibration and increase noise level.

a. Use of Tube Tester. Remove and test one tube at a time. Put back the original tube, or insert a new one if required, before testing the next one. Check tubes for transconductance, gas, and microphonics. Discard a tube if the tube tester shows it to be defective. Replace a tube that tests at or near its minimum test limit on the tube tester. If the new tube does not correct the trouble, replace the original tube.

b. Tube Substitution Method. Replace a suspected tube with a new tube. If the equipment still does not work, remove the new tube and try another new tube then put back the original tube. Repeat this procedure with each suspected tube until the defective tube is located.

42. Replacement of 1,000-Cps Filter Z1

a. Remove the panel-chassis assembly from the housing (para 11*a*).

b. Loosen the screw that attaches the filter clamp and swing the clamp away from the top of the filter.

c. Pull 1,000-cps filter ZI straight up out of its socket.

d. Insert the new 1,000-cps filter ZI into its socket.

e. Swing the filter clamp over the top of the filter so that it is positioned on the top center of the filter. Tighten the screw that attaches the filter clamp securely.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

43. Disassembly of Equipment

Disassemble the standing wave indicator as follows:

a. Disconnect the ac power cord from the power outlet.

b. Disconnect all cable assemblies from the front panel.

c. Coil the power cord and monitor cable.

44. Repackaging for Shipment or Limited Storage

The exact procedure for repackaging depends on the material available and the conditions under which the equipment is to be shipped or stored. Adapt the procedures outlined below whenever circumstances permit. The information concerning the original packaging (para 9) will also be helpful.

a. Material Requirements. The following materials are required for packaging Indicator, Standing Wave Radio AN/UPM-108. For stock numbers of materials, consult SB 38-100.

Material	Quantity
Waterproof paper	30 sq ft
Waterproof tape	18 ft
Corrugated cardboard	30 sq ft
Gummed tape	12 ft
Filler material	6 lb

b. Packaging. Package the items of the standing wave indicator as follows:

(1) *Standing wave indicator.* Cushion the standing wave indicator on all surfaces with pads of filler material. Place the cushioned unit within a wrap of corrugated cardboard. Secure the wrap with gummed tape.

(2) *Monitor cable and running spares.* Place each item in a wrap of corrugated cardboard with filler material separating each item.

c. Packing.

(1) Wrap each of the packages in waterproof paper.

(2) Place the package containing the standing wave indicator in a wooden box.

(3) Place the package containing the monitor cable and running spares in the wooden box on top of the standing wave indicator.

(4) Nail a wooden lid on the box.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

45. Authority for Demolition

The demolition procedures given in paragraph 47 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

46. Methods of Destruction

Any or all of the methods of destruction given below may be used. The time available will be the major determining factor for the methods to be used when destruction of equipment is undertaken. The tactical situation also will determine in what manner the destruction order will be carried out.

a. Smash. Use sledges, axes, hammers, crowbars, and any other heavy tools available to smash the panel-chassis assembly.

(1) Remove the panel-chassis assembly from the housing. With a heavy hammer or bar, smash all exposed parts.

(2) Use the heaviest tool on hand to smash the meter, front panel, and knobs.

b. Cut. Use axes, handaxes, machetes, and similar tools to cut cabling, cording, and wir-

ing. Use a heavy axe or machete to cut the power cord. Cut all cords and cables in a number of places. If time permits, remove the panel-chassis assembly from the housing and slash all internal cabling and wiring.

c. Burn. Burn as much of the equipment as is flammable; use gasoline, oil, flamethrowers, and similar tools. Burn the technical manuals first. Pour gasoline on the cut cables and internal wiring and ignite it. Use a flamethrower to burn spare parts or pour gasoline on the spares and ignite them. Use incendiary grenades to complete the destruction of the panel-chassis assembly.

***Warning:* Be extremely careful with explosives and incendiary devices. Use these items only when the need is urgent.**

d. Explode. Use explosives to complete demolition or to cause maximum damage when time does not permit complete demolition by other means. Powder charges, fragmentation grenades, or incendiary grenades may be used. Incendiary grenades usually are most effective if destruction of small parts and wiring is desired.

e. Dispose. Bury or scatter destroyed parts or throw them into nearby waterways. This is particularly important if the equipment has not been completely destroyed.

APPENDIX I

REFERENCES

Following is a list of references available to first and second echelon personnel assigned to the operation and maintenance of Indicator, Standing Wave Ratio AN/UPM-108.

DA Pam 108-1	Index of Army Motion Pictures, Television Recordings, and Filmstrips
FM 21-5	Military Training
FM 21-6	Techniques of Military Instruction
FM 21-30	Military Symbols
SB 38-100	Preservation, Packaging, and Packing Materials, Supplies, and Equipment Used by the Army
SR 320-5-1	Dictionary of United States Army Terms
SR 320-50-1	Authorized Abbreviations

APPENDIX II

MAINTENANCE ALLOCATION CHART
INDICATOR, STANDING WAVE RATIO AN/UPM–108

Section I. INTRODUCTION

1. General

a. This Appendix assigns maintenance functions and repair operations to be performed by the lowest appropriate maintenance echelon. It also specifies the tools and other equipment authorized at each echelon to perform the assigned maintenance functions.

b. Columns in the maintenance allocation chart are as follows:

(1) *Part or component.* This column shows only the nomenclature or standard item. Additional descriptive data are included only where clarification is necessary to identify the part. Components and parts making up the major end item are listed alphabetically. Assemblies and subassemblies are in alphabetical sequence with their components listed alphabetically immediately below the assembly listing.

(2) *Maintenance function.* This column indicates the various maintenance functions allocated to the echelon capable of performing the operation.

(a) Service. To clean, to preserve, and to replenish fuel and lubricants.

(b) Adjust. To regulate periodically to prevent malfunction.

(c) Inspect. To verify serviceability and to detect incipient electrical or mechanical failure by scrutiny.

(d) Test. To verify serviceability and to detect incipient electrical or mechanical failure by use of special equipment such as gages, meters, etc.

(e) Replace. To substitute serviceable assemblies, subassemblies, and parts for unserviceable components.

(f) Repair. To restore to a serviceable condition by replacing unserviceable parts or by any other action required utilizing tools equipment, and skills available, to include welding, grinding, riveting, straightening, adjusting, etc.

(g) Align. To adjust two or more components of an electrical system so that their functions are properly synchronized.

(h) Calibrate. To determine, check, or rectify the graduation of an instrument, weapon, or weapons system, or components of a weapon system.

(i) Rebuild. To restore to a condition comparable to new by disassembling the item to determine the condition of its component parts and reassembling it using serviceable, rebuilt, or new assemblies, subassemblies, and parts.

(3) *1st, 2d, 3d, 4th, and 5th echelon.* The symbol X indicates the echelon responsible for performing that particular maintenance operation, but does not necessarily indicate that repair parts will be stocked at that level. Echelons higher than the echelon marked by X are authorized to perform the indicated operation.

(4) *Tools required.* This column indicates codes assigned to each individual tool equipment, test equipment, and maintenance equipment referenced. The numbers in column 8 of the maintenance allocation chart indicate the tool, test, and maintenance equipments required to perform the maintenance function. These numbers are identified in Section III, Allocation of Tools for Maintenance Functions.

(5) *Remarks.* Column 9 contains any notations necessary to clarify the data cited in the preceding columns.

c. Columns in allocation of tools for maintenance functions are as follows:

(1) *Tools required for maintenance functions.* This column lists the tool and test equipment required to perform the maintenance functions.

(2) *1st, 2d, 3d, 4th, and 5th echelon.* The dagger symbol (†) indicates that the tool or test equipment is allocated to that echelon.

(3) *Tool code.* This column lists the tool code assigned.

2. Maintenance by Using Organization

When this equipment is used by signal service organizations organic to theater headquarters or communication zones, those maintenance functions allocated up to and including fourth echelon are authorized to the organization operating this equipment.

3. Mounting Hardware

The basic entries of the maintenance allocation chart do not include mounting hardware such as screws, nuts, bolts, washers, brackets, and clamps.

Section II. MAINTENANCE ALLOCATION CHART

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
INDICATOR, STANDING WAVE RATIO AN/UPM-108								
	service				X	X	2,3	
	adjust				X	X	1,3,4,5,6	
	inspect				X	X	6	
	test				X	X	1,2,3,4,5,6	
	repair				X			
	align				X	X	1,3,4,5,6	
	calibrate				X	X	1,2,3,4,5,6	
	rebuild					X		
BEZEL RING	replace				X			Fabricate if required
CABLE ASSEMBLY, POWER, ELECTRICAL CX-4864/U	replace	X						
	repair				X			
CABLE, POWER, ELECTRICAL	replace				X			
CONNECTOR, PLUG, ELECTRICAL UP-121M	replace		X					
PLUG, TELEPHONE	replace				X			
TERMINAL LUGS	replace				X			
CABINET ASSEMBLY	replace					X		Fabricate if required
	repair				X			
BAIL, CABINET TILT	replace				X			Fabricate if required
BUMPER, RUBBER	replace		X					
CABINET BODY	replace				X			Fabricate if required
REAR COVER, CABINET	replace				X			Fabricate if required
DETENT, CABINET BAIL	replace				X			Fabricate if required
HANDLE, CABINET	replace				X			Fabricate if required
INDICATOR, STANDING WAVE RATIO IM-157/U	repair				X			
	rebuild				X			
CAPACITORS	replace				X			
CHASSIS SLIDE	replace				X			Fabricate if required
CONNECTOR, RECEPTACLE, ELECTRICAL UG-1094/U	replace				X			
ELECTRON TUBES V1, V2, V3, V4	replace		X					
ELECTRON TUBES V5, V6, V7	REPLACE				X			

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/UPM-108 (continued)								
FILTER, BAND PASS	replace			X				
FUSE, CARTRIDGE	replace		X					
FUSEHOLDER	replace					X		
CAP, ELECTRICAL (f/fuseholder)	replace			X				
HANDLE, SWITCH	replace			X				
INSULATOR, PLATE	replace					X		Fabricate if required
JACK, TELEPHONE	replace					X		
KNOBS	replace			X				
LAMP, INCANDESCENT	replace		X					
LIGHT, INDICATOR	replace					X		
LENS, INDICATOR LIGHT	replace			X				
MULTIMETER	replace					X		
	repair						X	
OVEN, CROSS BAR	replace					X		Fabricate if required
PANEL	replace					X		Fabricate if required
PLATE, DESIGNATION	replace					X		Fabricate if required
PLATE, IDENTIFICATION	replace					X		Fabricate if required
RESISTORS	replace					X		
RETAINER, ELECTRON TUBE	replace					X		Fabricate if required
SEMI-CONDUCTOR DEVICE, DIODE	replace					X		
SHIELD, ELECTRON TUBE:	replace			X				
SOCKETS, ELECTRON TUBE	replace					X		
SPACER, SLEEVE	replace					X		Fabricate if required
SWITCH, LEVER	replace					X		
SWITCHES, ROTARY	replace					X		
SWITCHES, TOGGLE	replace					X		
TRANSFORMER, AUDIO FREQUENCY	replace					X		
TRANSFORMER, POWER, STEP-DOWN AND STEP-UP	replace					X		

Section III. ALLOCATION OF TOOLS FOR MAINTENANCE FUNCTIONS

(1) TOOLS REQUIRED FOR MAINTENANCE FUNCTIONS	(2) 1ST ECH.	(3) 2ND ECH.	(4) 3RD ECH.	(5) 4TH ECH.	(6) 5TH ECH.	(7) TOOL CODE	(8) REMARKS
AN/UPM-108 (continued)							
BRIDGE, SUMMATION AN/URM-23				†	†	1	
CRYSTAL RECTIFIER, TEST SET TS-268/U				†	†	2	
MULTIMETER AN/URM-105				†	†	3	
SIGNAL GENERATOR AN/URM-61				†	†	4	
SLOTTED LINE, WAVEGUIDE IM-92/U				†	†	5	
TOOL EQUIPMENT TE-113				†	†	6	

APPENDIX III

FIRST ECHELON FUNCTIONAL PARTS LIST INDICATOR, STANDING WAVE RATIO AN/UPM–108

Section I. INTRODUCTION

1. Scope

a. This appendix lists items supplied for initial operation and for running spares. The list includes parts and material issued as part of the major item. The list includes all items authorized for basic operator maintenance of the equipment. End items of equipment are issued on the basis of allowances prescribed in equipment authorization tables and other documents that are a basis for requisitioning.

b. The columns in Section II are as follows:

(1) *Source, maintenance, and recoverability code.* Not used.

(2) *Federal stock number.* This column lists the 11-digit Federal stock number. In the absence of a Federal stock number, an interim number, for example, ††L9Se49–10, in the "Description" column indicates that a Federal stock number is being processed for assignment. The L number may be used in emergencies to identify the item.

(3) *Designation by model.* Not used.

(4) *Description.* Nomenclature or the standard item name and brief identifying data for item are listed in this column. When requisitioning, enter the nomenclature and description on the requisition.

(5) *Unit of issue.* The unit of issue is the supply term applied to the smallest quantity by which the individual item is counted for procurement, storage, requisitioning, allowances, and issue purposes.

(6) *Expendability.* Expendable items are indicated by the letter X; nonexpendable items are indicated by NX.

(7) *Quantity authorized.* Under "Items Comprising an Operable Equipment" the column lists the quantity of items supplied for the initial operation of the equipment. Under "Running Spares and Accessory Items," the quantities listed are those issued initially with the equipment as spare parts. The quantities are authorized to be kept on hand by the operator for maintenance of the equipment.

(8) *Illustrations.* The "Figure No." column lists the figure on which the item is illustrated. The "Item No." column lists the reference designations that appear on the part in the equipment.

2. Critical Items

A zero slash (Ø) in the "Description" column indicates items that are expected to fail during the first year; also items that will make the equipment inoperative if they fail.

Section II. FIRST ECHELON FUNCTIONAL PARTS LIST

(1) SOURCE MAINTENANCE AND RECOVERABILITY CODE	(2) FEDERAL STOCK NUMBER	(3) DESIGNATION BY MODEL	(4) DESCRIPTION	(5) UNIT OF ISSUE	(6) EXPENDABILITY	(7) QUANTITY AUTHORIZED	(8) ILLUSTRATIONS FIGURE NO	(9) ILLUSTRATIONS ITEM NO
			ITEMS COMPRISING AN OPERABLE EQUIPMENT					
			INDICATOR STANDING WAVE RATIO AN/UPM-108					
	6625-682-4494		INDICATOR STANDING WAVE RATIO AN/UPM-108	ea	NX		1	
	6625-682-4493		INDICATOR STANDING WAVE RATIO IM-157/U	ea	NX	1	1	
	5995-682-3388		CABLE ASSEMBLY, POWER ELECTRICAL CX-4864/U	ea	NX	1	1	W3
			RUNNING SPARES AND ACCESSORY ITEMS					
			INDICATOR STANDING WAVE RATIO AN/URM-108					
			INDICATOR, STANDING WAVE RATIO IM-157/U					
	5960-166-7648		Ø ELECTRON TUBE: JAN type 0B2	ea	X	1	21	V7
	5960-166-7664		Ø ELECTRON TUBE: JAN type 12AX7	ea	X	2	21	V1 V2
	5960-262-0151		Ø ELECTRON TUBE: JAN type 6AU5GT	ea	X	1	21	V5
	5960-188-0943		Ø ELECTRON TUBE: JAN type 6AX5GT	ea	X	1	21	V4
	5960-230-5307		Ø ELECTRON TUBE: JAN type 6CB6	ea	X	1	21	V6
			ELECTRON TUBE: dual triode; 9 pin minature base; Phillips type E88CC per Amperex part No. 6DJ8 (††L9Se49-10)	ea	X	1	21	V3
	5920-636-3047		Ø FUSE, CARTRIDGE: 1 amp, 250 v; MIL type FO2G1R00B	ea	X	5	21	F1
	6240-155-8706		LAMP, INCANDESCENT: 6-8v, 0.15 amp; GE part No. 47	ea	X	1	21	I1
			INDICATOR, STANDING WAVE RATIO AN/URM-108					
			NO PARTS AUTHORIZED FOR STOCKAGE AT FIRST ECHELON					

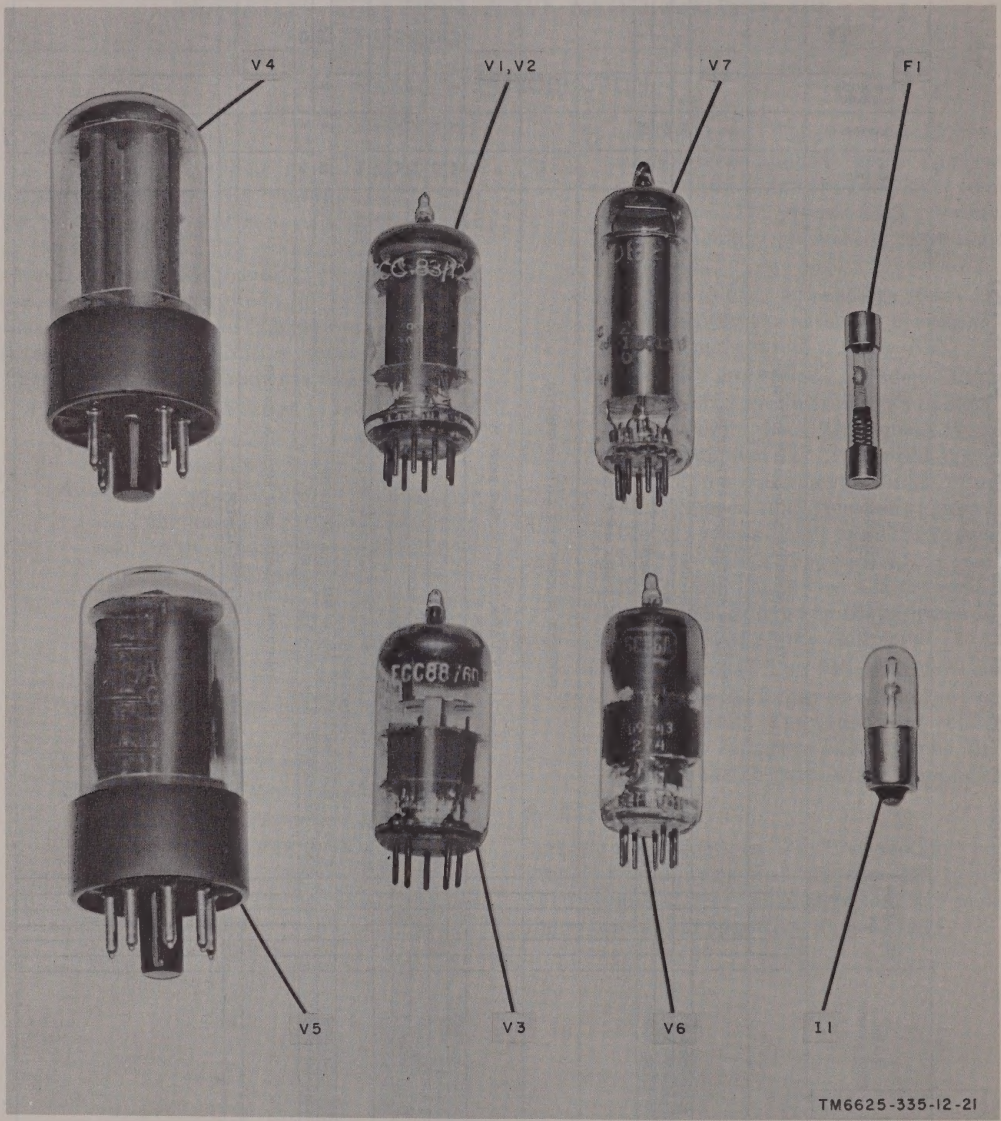


Figure 21.

By Order of *Wilber M. Brucker,* Secretary of the Army:

L. L. LEMNITZER,
General, United States Army,
Chief of Staff.

Official:

R. V. LEE,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

To be distributed in accordance with DA Form 12–7 requirements for TM 11 Series (UNCL), plus the following additional formula:

USASA (1)
CNGB (1)
Def Atomic Spt Agcy (5)
Tech Stf, DA (1) except
CSigO (18)
USA Abn & Elct Bd (1)
USA ATB (1)
US ARADCOM (2)
US ARADCOM Rgn (2)
MDW (1)
Seventh, US Army (5)
EUSA (5)
Corps (2)
JBUSMC (2)
Units org under the fol TOE: (2 copies each)
11–7
11–16
11–57
11–117
11–155
11–500 (AA–AE)
11–557
11–587
11–592
11–597

NG: None

USAR: None

For explanation of abbreviations used, see AR 320–50.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1960—522585/65